

NUTS & VOLTS

MAGAZINE



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DECEMBER 1996

Exploring Electronics And Technology For The Hobbyist And Professional

SANTA,
THE COOKIES,
ASK FOR YOU
AND THE
HUNDREDS
LOVE
A GOOD BY

*Merry Christmas
From All Of Us
At Nuts & Volts*



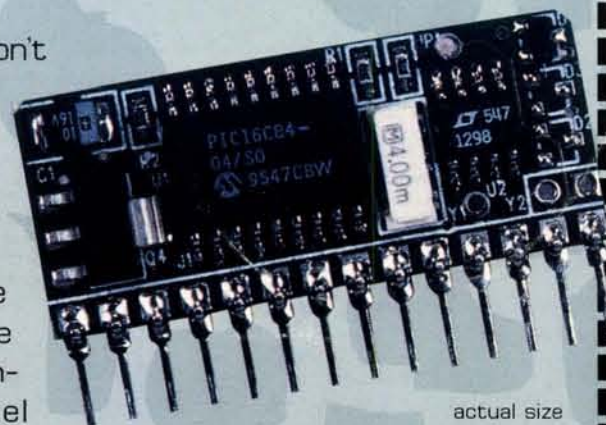
PicStic™

Compact Computing with an Attitude!

Happy users might describe PicStic™ as a BASIC Stamp® with an attitude, but we'd like to think that it's just a good idea advanced the way we like it.

PicStics™ are BASIC Stamp® I/O compatible 14-pin boards with a lot of extras. The primary gain is speed and performance. Any PBASIC program you have will automatically run 15 times faster on a PicStic™ using our PicBASIC compiler. Besides getting more speed and double the instruction space, Micromint gives program developers the option of using assembly language, BASIC, or C, along with this enhanced performance.

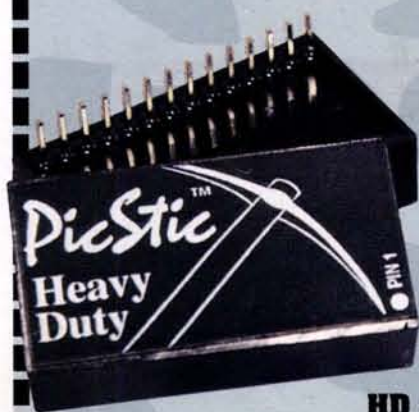
PicStic's™ features don't stop there. Besides more program memory and I/O lines, the PicStic™ 2 has a battery-backed hardware clock/calendar. The PicStic™ 3 has a high-speed, dual-channel 12-bit ADC.



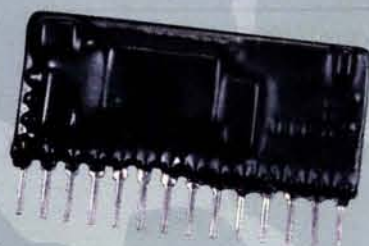
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HD



PC

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BS1 software compatible	yes	yes	yes	yes
Reprogrammable	yes	yes	yes	yes
I/O lines	10	9	10	8
Extra features	none	real-time clock	2-channel, 12-bit ADC	none
RAM (variables)	22 bytes	22 bytes	22 bytes	14 bytes
Max. program length*	150 ins	150 ins	150 ins	80 inst*
Clock speed	4 MHz	4 MHz	4 MHz	4 MHz
Execution speed	50k ins/sec	50k ins/sec	50k ins/sec	2k ins/sec
Max. serial I/O	9600 bps	9600 bps	9600 bps	2400 bps
Packaging**	14-pin SIP, protective coated or encapsulated	14-pin SIP or encapsulated	14-pin SIP or encapsulated	14-pin SIP

*Maximum program length and execution speed are determined by instruction mix.

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- IBM Compatible Reader/Writer for PCMCIA Cards
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- Includes driver disk, manuals, cable, internal card, bracket
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- New in box with software, 90-day warranty

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- Little box with lots of features...Unisys 486 workstation
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- Two 72-pin SIMM sockets, two SIO, one PIO on board
- On-board VGA (1MB, can add to 2MB), 10-BaseT LAN
- On-board IDE controller, Award BIOS, 256K Cache
- Will accept one short (7") ISA card
- Measures only 11.5" x 8.75" x 2"
- Intel 486DX-33 installed
- 90 day warranty
- There is an on-board floppy controller as well, but it is set up for a laptop-style .5" thick 1.44 floppy drive, with 26-pin printed ribbon cable. We do not have these drives. We suggest installing a 1" high 3.5" bootable IDE hard drive and using as a diskless network station.

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- Just in time for Christmas -- joysticks for computer games!
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- Like using a TV set remote control (easy to set-up, use)

HSC# 15240 IBM Remote Keyboard \$14.95

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- High performance fax machine, saves space and paper!
- D2 FAX by Seponix with FaxBoy software uses 3.5" floppy disks rather than paper for input/output
- May be used as back-up to existing fax machine, or as a stand-alone fax (no need to leave computer on-line!)
- Units are new in box with software, power supply, manuals
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- 90-day Warranty

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SCSI Drive Case Deal!

- Low-profile case for 5.25" drives
- Perfect for CD-ROM drive
- 9.75" x 2.25" x 11" overall size
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- Internal 50-pin cable, SCSI ID switch
- 30-watt power supply, DC Fan cooled
- New case is attractive grey color, has 90-day warranty

HSC# 16185 Low-Profile 5.25" Drive Case \$29.95

Tricky Tuned Mag-Switches!

- Ordinary magnetic switches used on doors and windows in security systems can be defeated by secretly placing another magnet next to the switch on the frame, where it doesn't move
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Deadlines should be discussed in advance with the editor, but generally all material should be submitted by the 1st of the month for the next month's issue.

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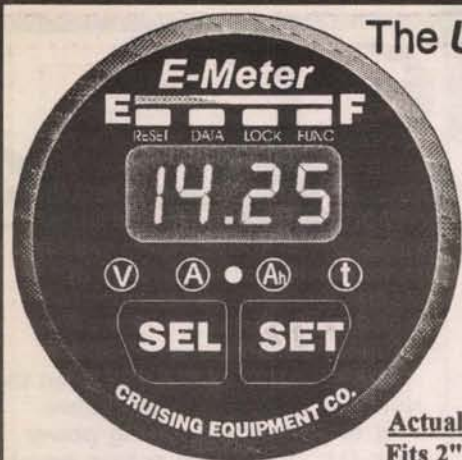
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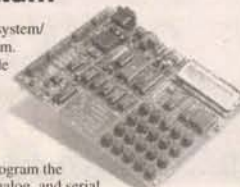
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reader FeedBack

Dear Nuts & Volts:

In the GREAT article on repairing PC power supplies ("PC Power Supply Repair" by TJ Byers, Sept. '96), I believe there is an error in the drawing (Figure 3) on page 11. The capacitors in the filter sections of the -5 volt and -12 volt supplies appear to be polarized incorrectly. Also the 10 uF cap on the input side of the 7905 regulator is apparently reversed, because the positive side is hooked to the -5 volt line. Since the -5 volts is referenced to ground, shouldn't the filter cap polarities be reversed to show the proper ground reference?

In Figure 6, the caps are shown correctly, relative to the "high-voltage common" line, and the =150V and -150V lines.

I've picked up copies of your magazine sporadically for the last few years, and have finally sent my subscription request. I should have done it two years ago!

Thanks for a job well done.

Rod Johnson KATYOU
via Internet

Response:

Yep, they're backwards. That's what happens when you work into the wee hours of the morning on deadline. Sorry. Thanks for the kind remarks, and catch my new series on solar power. I think you'll like it.

TJ Byers

Dear Nuts & Volts:

In the Oct. '96 Reader Feedback, Open Channel author Joe Carr stated that decibels can be defined for current, voltage, or power levels, and gave as the general formula:

$$dB = K \log (A/B)$$

with K = 10 for power and 20 for voltage, with no mention of impedance restrictions.

One could define a dollar as 15 cents, too; but this would cause confusion because it conflicts with another definition already in wide use. Redefining decibels in terms of voltage ratios (where Z1 and Z2 are not necessarily equal) produces results incompatible with the original definition in terms of power ratios. If we insist that the voltage-dB equation be limited to cases where Z1 = Z2, 6 dB will always be 6 dB, and the confusion that prompted Joe's reply to a reader would be avoided.

The IEE Standard Dictionary of Electrical and Electronics Terms, 4th ed., 1988, defines decibel as "10 times the logarithm to base 10 of a ratio of two powers," and gives the equation:

$$n = 10 \log (P2 / P1) \text{ decibel}$$

It goes on to say that when the ratios of voltages is the square root of the corresponding power ratio (i.e., measured across equal impedances) decibels may be calculated as:

$$n = 20 \log (V1 / V2) \text{ decibel}$$

Finally, it states "these relations ... are sometimes applied where these ratios are not the square roots of the power ratios ... Such extensions of the term should preferably be avoided."

One final note: dB is not a quantity symbol; it is a "unit" symbol (although a phantom unit, since it has no dimension). We should not write dB = 6, but rather G = 6 dB.

Dan Metzger K8JWR
Lambertville, MI

Dear Nuts & Volts:

You have some advertisers who are hiding their light under a basket. As Don Lancaster pointed out long ago, one of the best ways to create printed circuit board artwork is with Postscript. What no one seems to know, including authors of recent PCB CAD reviews, is that Ohio Automation's low-priced package, called entry level BOARDMAKER, creates Postscript as an output option. The output is an ASCII file. I use DOS PRINT to send the output file to a Postscript equipped NEC Silentwriter laser printer, to create camera-ready artwork. I send the artwork to either Circuit Design (541-664-7904) for single sided, or Atlas Circuits (704-735-3943) for single or double sided. Both do excellent work and have fast turnaround. Their addresses are in the classified section.

J. Dennon
Warrenton, OR

Dear Nuts & Volts:

I just got back from vacation and, to my delight, the newest edition of Nuts & Volts (Oct. '96) was waiting for me. Before unpacking or anything else, I wanted to whet my appetite for the new projects and concepts I would be studying later. I read the first article on Solar-Powered Varmint Zapper with much interest, but have not been able to move on to any of the other articles.

When I read at the end of the article that Mr. Charlton had passed away on Sept. 22, I was in shock. Having corresponded with him on several occasions, I had become respectful of his knowledge, as well as his generosity. He did not let on, nor gave any clue that he might have been ill or

Continued on page 111

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Nuts & Volts Magazine/December 1996 7

A BEGINNER'S GUIDE TO WORLD WIDE TELEVISION STANDARDS

by Fernando Garcia

Every person who lives within North America expects to be able to tune a TV signal regardless of the TV brand, signal source, or area where the person lives.

This is thanks to TV broadcast standards, which assure signal compatibility.

Compatibility is taken for granted, much as the air we breathe. Nevertheless, travelers to Europe who purchase prerecorded video-cassettes are surprised and disappointed to come home and realize that they purchased an unviewable video. The reason being that in Europe, and in most parts of the world, there are very different television standards which are incompatible with "American" TV signals. As you read the following article, you'll realize how distinct and diverse the world wide TV signals really are.

There are a number of reasons for these barriers of incompatibility. Unfortunately, very few were imple-

mented for technical reasons, most have been implemented for economic and political motives.

Television has traditionally been a very powerful tool for companies to sell their products and for some governments which would like to manipulate politically or isolate their citizens from foreign culture. The TV industry and its associated production and distribution is a large business by itself, and thus one that many nations wish to protect.

The purpose of this short introduction is not to give an exact description of the complex world of TV standards or to overload you with data, but rather to attempt to provide a brief understanding of the differences between world standards.

A short discussion on how to bridge the different systems will also be provided. To understand the different standards and the lack of compatibility, an introduction of how TV signals operate is in order.

To allow a TV picture and sound to be received, the signal has to provide four sub-components, as follows: timing and synchronization; bandwidth assignments; color encoding; and sound.

TIMING AND SYNCHRONIZATION

To provide the illusion of movement, the TV industry borrowed the same concept employed in the movie industry, namely to present a series of still pictures (or frames) in very rapid succession. To reduce the flicker without an undue increase of bandwidth, the TV frame is divided in two fields, each of which carries half of the frame information. The two fields are interleaved during scanning to present

the frame information.

Thus, the first important parameter in a TV signal is its vertical frequency, or field rate. To minimize line-related hum in early TV sets, it was decided to employ a field rate equal to the power line frequency.

As the world electric utilities employ either 50 or 60 Hertz, this immediately divided the world-TV standards into two different camps, as shown in Figure 1. Actually, the 60 Hertz system is not quite so, to accommodate color signals it was adjusted slightly to 59.94 Hertz, but for simplicity people still refer to it as 60 Hertz.

Figure 2 shows an oscilloscope display of a pair of TV fields. Modern TV-receiver power supplies have improved the ripple rejection to the extent that the field repetition rate need not be tied to the power line frequency. But the standards are deeply rooted now and it is unlikely that modifications will occur.

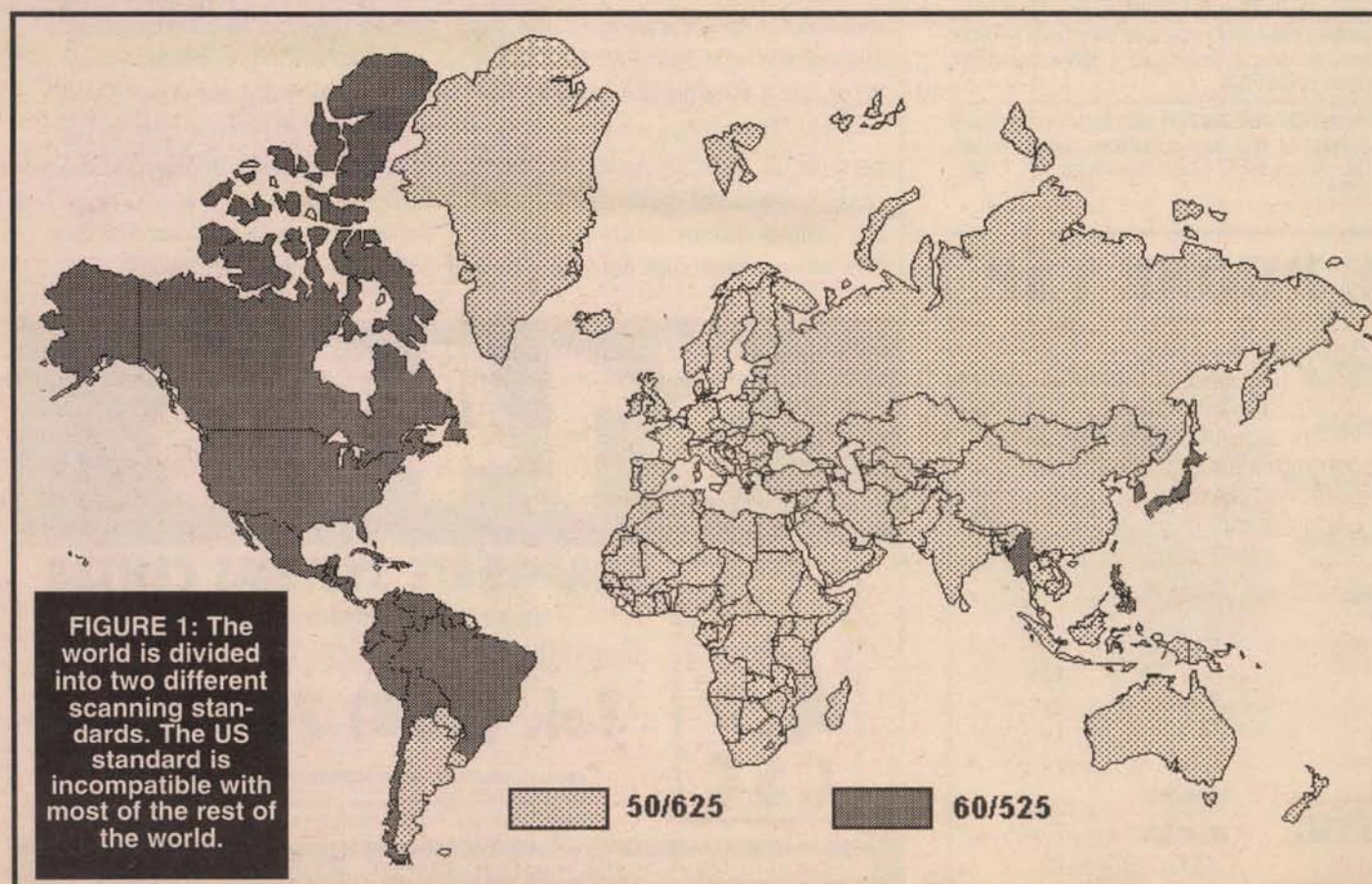
The second synchronization component is its horizontal or line rate. A picture made with 35-mm film presents complete frames, but on a TV signal, the frame has to be scanned. Each frame is "painted" on the CRT screen by a rapidly moving electron beam that draws individual horizontal lines.

A good question would be how many lines to use. Of course, the capability to resolve picture details (resolution) increases with a higher number of lines. The penalty for increased resolution is an increase in the already large TV-channel bandwidth.

Since the TV industry was competing with an established movie industry, a similar horizontal resolution would seem to have been an appropriate choice.

Appropriate does not necessarily mean practical, as the 1,500-plus line resolution of 35-mm film would have resulted in an impossibly large channel bandwidth.

Line frequencies from 405 to 819 were experimented with worldwide, before settling with 525 lines per frame for the 60-field systems, and 625 lines per frame for the 50-field systems. If you perform a sim-



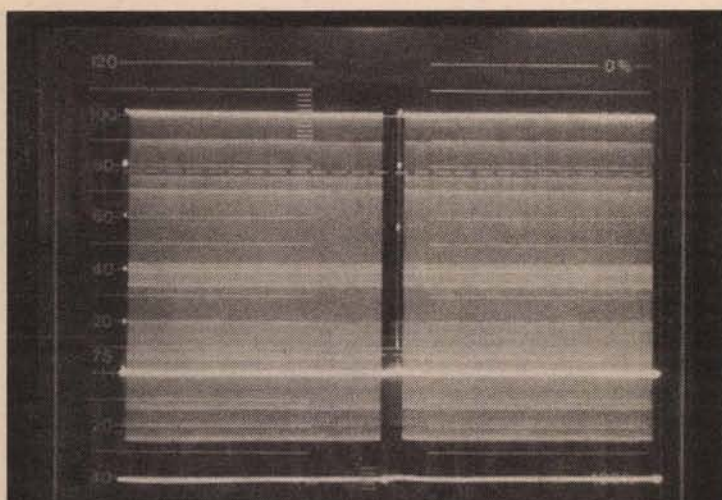


FIGURE 2: Oscilloscope display of a TV field pair. Vertical sync is located in the middle gap. Its repetition rate provides the "Field Rate."

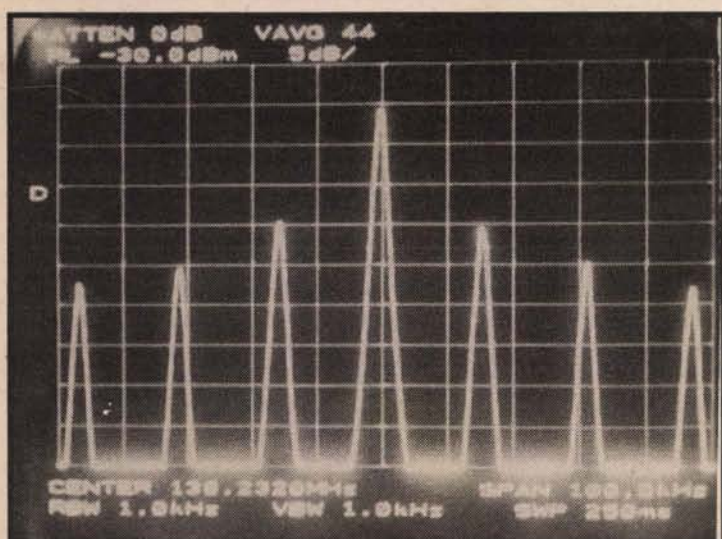


FIGURE 4: Spectrum analyzer plot of a TV signal. The highest peak is the carrier. Please note the frequency gaps between the carrier and the sidebands.

ple multiplication, you may notice that the total amount of lines per second is very similar for both systems. Figure 3 shows a pair of TV lines.

BANDWIDTH AND THE CCIR LABELING SYSTEM

The total amount of lines per second is one factor that determines the required spectrum space, or bandwidth. The second factor is the resolution required by the picture elements, or pixels, on each individual line. If bandwidth was free, then, in theory, you could have unlimited resolution. The broadcast spectrum is actually a limited commodity, and when spectrum space was being allocated for TV broadcasting, people would balk at the enormous bandwidth required.

Just imagine that a single TV

channel would occupy almost as much bandwidth as six times the entire AM broadcast band! This gets even worse with some European systems.

Not all the channel bandwidth is useable video bandwidth. A portion of it is dedicated to the vestigial sideband, the guardbands, and the sound subcarrier, thus only about 70% of the total channel bandwidth is available for the picture. The video bandwidth will limit the theoretical maximum number of pixels.

During the early stages of the TV industry, there was a very large number of incompatible systems. Though this is still true today, some order has been brought up by the CCIR, the International Committee which regulates international radio communications. It set up a group of preferred standards that would regulate the transmission of

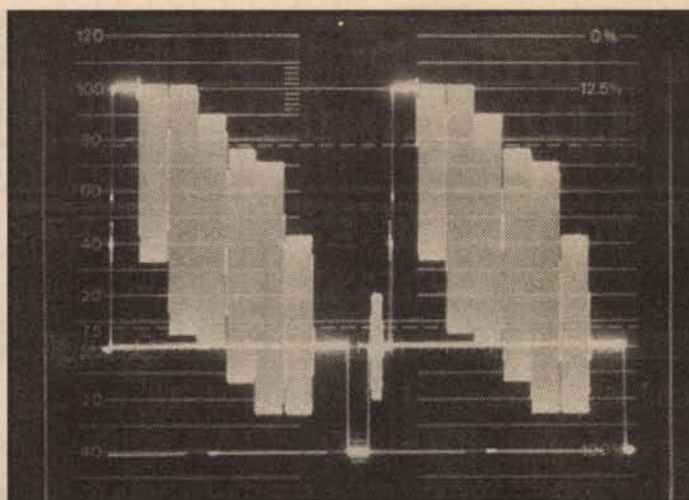


FIGURE 3: Oscilloscope display of a TV line pair. Color burst and sync pulses are clearly visible.

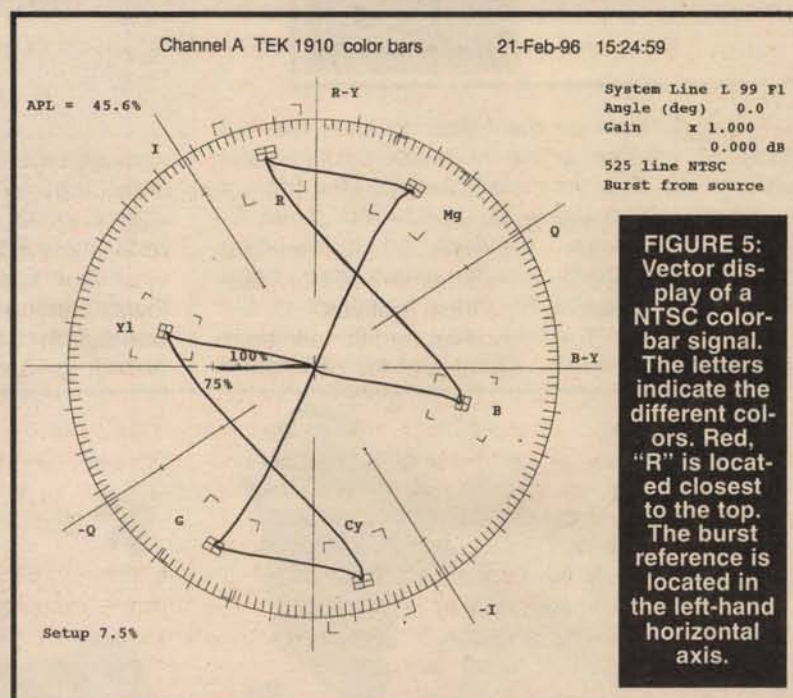


FIGURE 5: Vector display of a NTSC color bar signal. The letters indicate the different colors. Red, "R" is located closest to the top. The burst reference is located in the left-hand horizontal axis.

Monochrome TV scanning and bandwidth, and hopefully consolidate and reduce the number of standards.

This caused some standards to be dropped, like the 819-line French system which had an excellent resolution, but excessive bandwidth requirements.

The different standards were labeled with letters. The "M" system for instance, is being used in all of North America and most of South America. The systems standards provide information on the number of lines per frame, the number of fields per second, channel bandwidth, and other parameters related only to monochrome TV. This is shown in Table 1.

Some systems sport two letters, like the "B/G" system. In this instance, the first letter is the standard for VHF transmissions, the second letter is for UHF transmissions.

COLOR ENCODING

Color TV has become so ubiquitous that

people seem to forget that black and white-only TVs were the only option available for many years. The history of the transition from black and white to color broadcast is fascinating and extensive, and beyond the scope of this short article. Suffice it to say that clever means were found to encode three different color primaries into existing TV signals without increasing bandwidth and allowing backward compatibility with existing monochrome TVs.

The TV industry again borrowed concepts from the film industry for color signals. Most of the colors you see can be generated with just three primary colors: Red, Green and Blue. This is known as an RGB signal.

To generate a monochrome or luminance signal from RGB signals is a straightforward process: just add the signals together. It is simple to perceive that full level RGB signals would make white, and that a total absence of them would generate black. Likewise, varying amounts of signals would generate all the different shades of gray.

The resultant monochrome or luminance signal modulates the main picture carrier. The actual manner in which the chroma subcarrier is modulated is the major distinction between the different systems, NTSC

(National Television System Committee), PAL (Phase Alternating Line), and SECAM (Sequentielle Couleur Avec Memoire).

The color information is encoded via what is referred to as chroma-difference signals. Blue is subtracted from the luminance, and red is subtracted from luminance. The pair of chroma-difference signals modulate the color subcarrier.

The trick is how to insert the color subcarrier without increasing the total TV signal bandwidth. Fortunately, the monochrome signal does not occupy the complete spectrum available within a TV channel. Rather, the signal clusters around multiples of the horizontal frequency, as shown in Figure 4, meaning that there are many empty gaps across the spectrum. Television researchers found a way to implement the color subcarrier such that its sidebands fall into the otherwise unused gaps. The trick is to carefully select a subcarrier frequency which is an odd multiple of half the horizontal scanning frequency.

In addition, you want this subcarrier to be far away from the main picture carrier, to prevent beating between the two carriers. Those constraints led to the selection of the chroma subcarrier frequencies

TABLE 1: CCIR definitions for Broadcast TV signals

CCIR System	Fields Second	Lines/Frame	Channel BW, MHz	Video BW, MHz	Video Modulation	Audio Subcarrier, MHz
M	60(*)	525	6	4.2	negative	4.5
N	50	625	6	4.2	negative	4.5
B/G	50	625	7/8	5	negative	5.5
I	50	625	8	5.5	negative	6.0
L	50	625	8	6	positive	6.5
D/K	50	625	8	6	negative	6.5

(*) Changed to 59.94 for color transmission

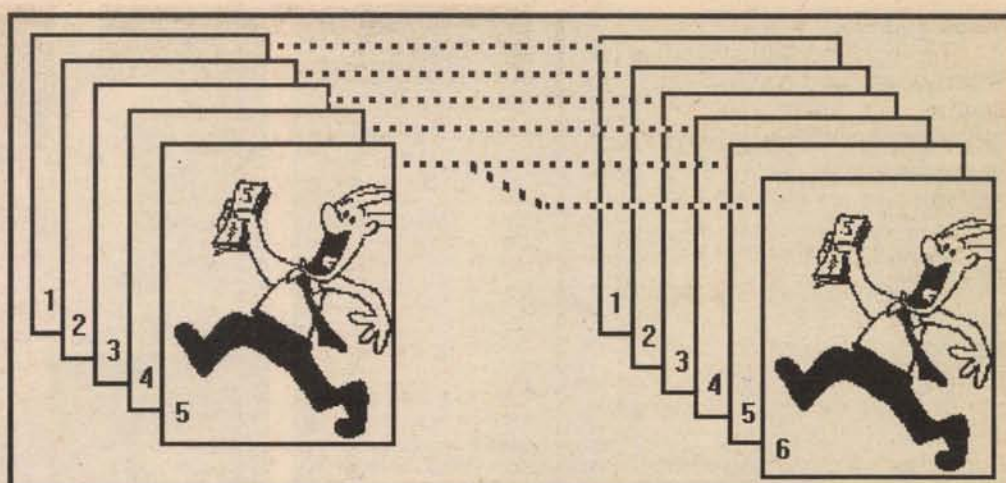
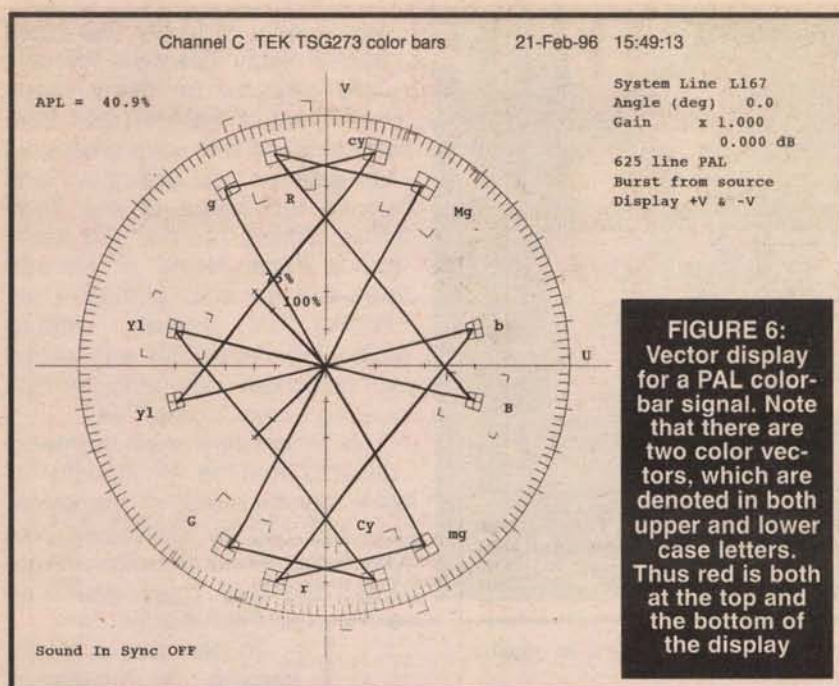


FIGURE 8: To transcode from 50 to 60 frames per second, every fifth frame is repeated twice.

TABLE 2: Chroma subcarrier frequencies (MHz)

NTSC	PAL /B/G/I	PAL /M	PAL /N	SECAM
3.57954	4.43361	3.57561	3.58205	4.40625 and 4.25000

shown in Table 2.

NTSC is the granddaddy of color TV. It takes the pair of chroma-difference signals and utilizes them to phase modulate the chroma subcarrier. Phase modulation is achieved by having the first chroma-difference signal modulate an in-phase carrier, the second signal modulates a quadrature (shifted 90 degrees) carrier. The phase reference is provided by the color burst, which is located in the back porch following horizontal sync. Different phase angles mean different colors. A typical vectorscope display of an NTSC color-bar test pattern is shown in Figure 5.

Clever as it is, NTSC suffers from shortcomings due to compromises made in its vacuum-tube design era, which severely restricted the receiver's complexity. The most objectionable shortcoming is the phase shift that occurs in any transmitting-receiving path. This had the effect of producing different tints (hue) in every channel. Thus, the ubiquitous tint or hue control present in all TVs. This led to an old joke among TV engineers which said that NTSC stood for Never Twice the Same Color.

The German-developed PAL system also employs phase modulation, but tries to overcome the inevitable phase shifts with a clever technique, which alternates the phase of the burst reference every line.

The alternating phase is clearly seen on the vectorscope picture of Figure 6. If a phase shift occurs during the receiving path, the phase error will add on one line, but sub-

tract on the following line. The net effect is that the phase error cancels to a very large extent. This feature and the wider bandwidth of the B-system, provides an outstanding picture quality which has been adopted by more countries in the world than any other system. However, PAL receivers are more

ence signals. So radical is the difference, that TV engineers have jokingly dubbed it System Essentially Contrary to American Method.

Instead of employing a phase modulation technique, SECAM employs frequency modulation of a carrier pair. This dual carrier is

nal, and thus would not be left alone either. For instance, while almost all countries employ FM modulation for the sound carrier, different frequency-deviation values are employed, and at least one country (France) employs AM modulation for the sound carrier!

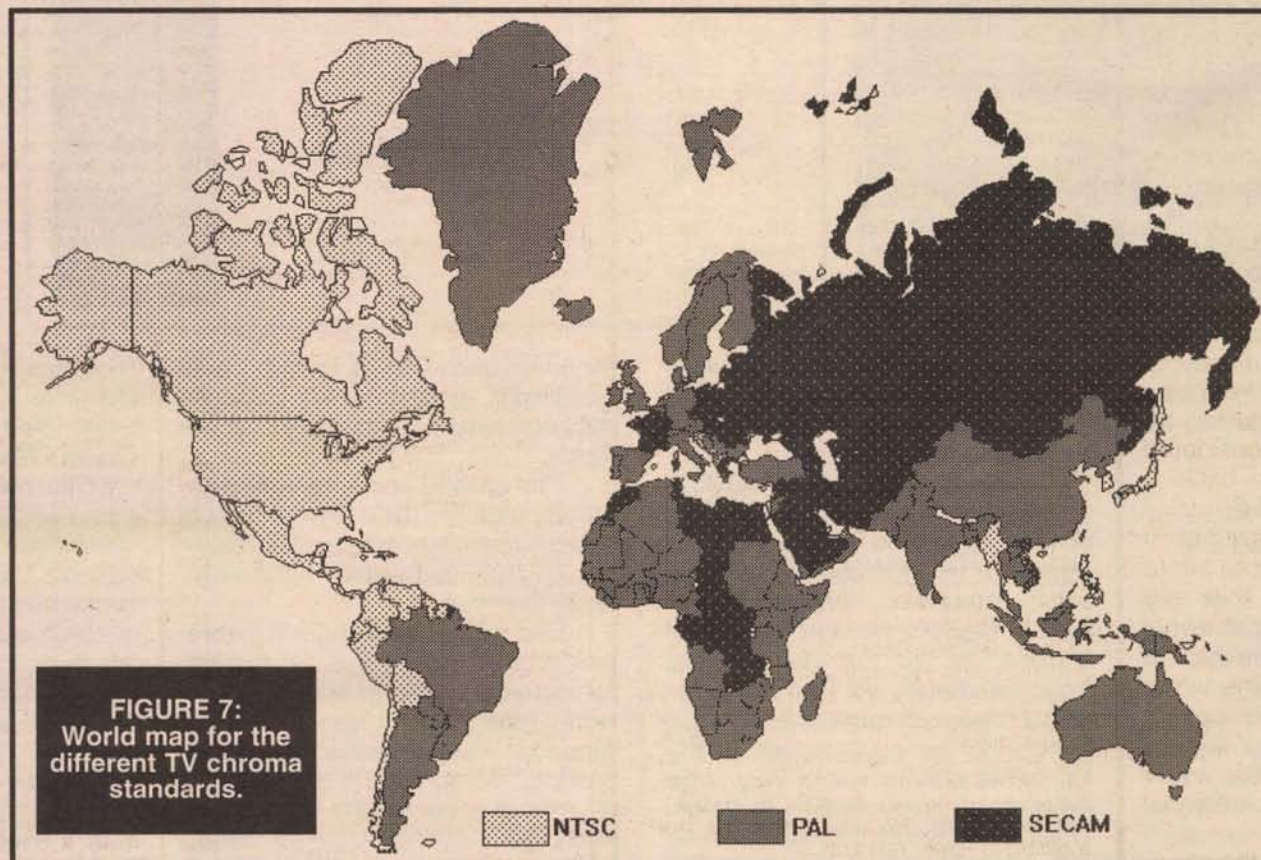
Stereo sound systems complicate matters further. American systems employ a variant very similar to the FM-stereo radio broadcasts, on which a single sound carrier provides the monophonic signal, a pilot tone, the stereo difference signals, and an auxiliary (second language) signal.

The main change between TV and radio consists in that the pilot tone on the TV systems is related to the horizontal frequency (15.734 KHz) instead of broadcast radio's 19 KHz. An improved system which provides better signal-to-noise and frequency response is the German twin carrier, FM-FM system.

Again, the improvement comes at a cost.

As its name implies, two independently FM-modulated sound carriers are broadcast, the first which provides the monophonic signal, and the second which provides the stereo-difference signals. This second carrier may be used for auxiliary programs.

In both these instances, a decoder matrix is required to separate the left and right audio channels. Though this offers reasonable sound with simple circuitry, being analog in nature, the separation and signal-to-noise of stereo signals is not comparable to true high fidelity



complex, and they have thus been nicknamed Pay for Added Luxury.

The PAL technique has been adapted to other systems which have wider and narrower bandwidths than the B-system as shown in Table 1, resulting in the types I, M, and N variants. A different chroma subcarrier frequency is required to accommodate different video bandwidths and scanning frequencies of each variant, but the basic alternating phase principle remains the same.

The French-developed SECAM system employs a radically different approach to encode the color-differ-

shown in Table 2. Think of it as an enlightened and much enlarged version of the tone pairs used by telephone companies to dial numbers. The subcarrier pairs are transmitted sequentially, and one of them is stored in a delay line (thus the "memory" description of the acronym) to allow it to be drawn concurrently on the TV screen. Figure 7 shows a map of the different worldwide color standards.

SOUND REPRODUCTION

Of course, sound is a very important component on a TV sig-

stereo sound.

The most modern system is the British-developed NICAM-728. This system, introduced in the late 1980s, provides digital modulation for the stereo sound signal. NICAM-728 employs a 14-bit, 32 KHz sample rate.

Although not as good as the compact disc sampling rate, it nevertheless provides substantial improvements in sound quality. The circuitry to recover it is significantly more complex and expensive. However, with the cost and size reductions of digital audio circuitry driven by compact discs and other digital audio applications, prices should come down.

TRANSCODING

The different TV standards have been traditionally formidable obstacles for the transfer of video signals around the world. Traditionally, it had involved copying the TV signal into film, and then transferring the film images to other TV signal format. This was not only awkward and time-consuming, picture quality also suffered.

Professional studios also employed transcoders, on which a TV signal would be electronically separated into its individual components and re-encoded into the incompatible format. Like all early video equipment, the transcoders were large and very expensive equipment.

Fortunately, with the ever increasing power of electronic circuits, multi-standard TVs and VCRs have become available. Although relatively expensive compared to standard devices, it is an amazing feat for a consumer device to provide such a capability, considered impossible just a few years back.

And even professional quality transcoders are reasonably priced such that smaller studios can afford them. The difference in cost and complexity between professional and consumer transcoders has to do with how they handle the different line/frame rates. Without going into much detail, suffice it to say that going from 60 to 50 fields, every sixth field is dropped on commercial grade transcoders.

Likewise, when going the opposite direction from 50 to 60 fields, the fifth field is repeated to fill the gap as shown in Figure 8. This may or may not be noticeable, depending on the picture content.

Professional grade transcoders will interpolate motion between frames and then decimate it to a lower or higher rate. This requires a very powerful processor and large amounts of memory which are the reason for the increased cost of the professional versions.

Similar line dropping or repeating techniques are employed to handle the 525/625 line-rate conversion. **NV**

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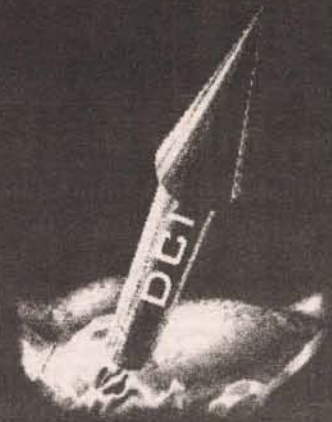


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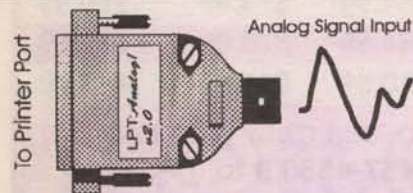
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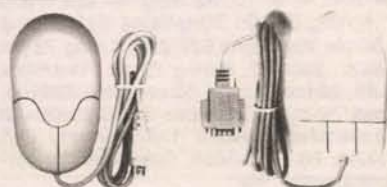
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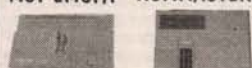
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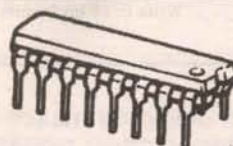
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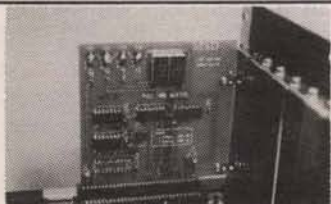
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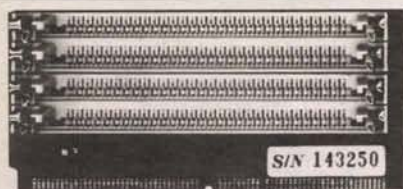


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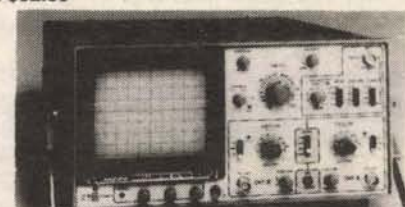


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Questions & Answers

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts* readers and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and **NO GUARANTEES WHATSOEVER** are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

I need technical and programming information on the "Sleuth" — a device which connects between one's modem and the phone line. It intercepts incoming calls and requires a password before allowing the caller to access the modem. The manufacturer is, I am told, out of business.

My thanks to anyone who can show me how to reprogram this puppy.

12961 Jack Meagher
Closter, NJ
w2ehd@aol.com

A while back, a friend gave me his old fax machine (9600 baud or so) and I was wondering what circuit I can whip up to use it as a scanner? I have a computer with fax modem capability and I am using Procomm Plus Win ver 3.0. I don't have two phones or that would be easy.

I have seen units advertised to do this for \$99.00 or so. It seems a little expensive, as there can't be that much involved. Can I just make up a circuit with a 48 VDC loop and some load resistors to simulate the phone line?

I would draw a schematic here, but my E-Mail art isn't too good. But the circuit I was thinking of would have, say, a 1 K resistor in series, and maybe 1 K resistors across the fax and computer lines. Would this work?

12962 Mark Sklaney
Alden, PA

Is there a book or catalog that shows the different type of hook-ups for VCR to TV to scrambler to play and record while watching another channel?

12963 Don Shuey
Newark, DE

In my mobility cart, there are two 12-volt gel-cell batteries. I am trying to come up with a way to charge the gel-cells from the 100 amp alternator in the car without ruining them. Any help would be appreciated.

12964 Lou Delaney
Highland Heights, KY

Can someone supply a source for an in-line lighting arrester for CB cable? Radio Shack does not have them anymore.

12965 Donald McKnight
Salisbury, NC

I have a Roberts reel-to-reel tape recorder that's missing a take-up spindle and other parts needed to perform its job. This recorder (it's a 1725 I believe) records from reel-to-reel and to eight-track tapes, when working. It's hard enough to get prerecorded reel-

to-reel tapes now. This recorder and I have gone through too much together to give up now. Please advise as soon as possible. I'm no electronic whiz and I just got my amateur radio license. I'm also working on getting into amateur radio packet radio two-meter through my C-64 Commodore 64 computer.

12966 Michael G. Hazelett
Edgewater, CO

I have a blower motor that has the following nameplate data: A 1.50, V 200, RPM 3500, PH 3, and HZ 400. I would like to run this motor on 3 PH, 220 V and 60 Hz. Variable RPM would be desirable, but not necessary. Any help?

12967 Roger Ruth
Victoria, TX

I want to control eight loads via remote control (AM or infrared). The distance for my application is 50-100 feet. The environment operation is noisy. Where can I find something out for this application?

12968 Lety Guerrero Garcia
Hidalgo, TX

I need to insert into a video stream the time (and date if possible). To do this, I need a source for any one of the following ICs:

MM58106 TV Clock Display IC
MM5841 TV Channel/Clock Display
MM5840 TV Channel/Clock Display
MM5318 TV Channel/Clock Display
MM53100 TV Timer IC
MM53105 TV Timer IC

This problem was previously submitted, but the answer was not satisfactory. The IC from clock printed circuit board from a Heath Co. GR2000 TV could be used (this is the MM5318 IC listed above).

12969 Robert M. Harkey
Charlotte, NC

I have a cellular bag phone (make Technophone, model #MC905A/915A) that served me well, but has been replaced with a flip phone. Can someone give me the test and diagnostic codes and procedures for my retired Technophone?

129610 James Bryden
Modesto, CA

ANSWERS

ANSWER TO #11966 - NOV. 1996

It sounds like Mr. Katznelson is trying to come up with the equivalent of the magnetic floor sweeper, except it should pick up everything rather than just ferrous materials. The idea of using an electrostatic charge to hold

or pick things up is a sound one. Electrostatic copiers and laser printers use an electrostatic charge to transfer the toner from storage, to drum, to paper. And the old physics experiment with glass, hard rubber, rabbit's fur, and pith balls also demonstrates the principal. I've even seen plotters that used an electrostatic field to hold the paper in place during plotting, and electrostatic precipitators and air cleaners remove all manner of small particles from the air. The idea of using electrostatic fields for moving or holding large, generic objects falls short of being practical, however.

The laws of physics show that a given electrostatic charge can indeed attract an object, and whether or not it moves, there is an attraction given certain circumstances. The primary circumstance is that the charges must be opposite. Items charged to the same potential (value and polarity) will repel each other; the object reader Katznelson tries to pick up, therefore, must be of opposite charge to his charged bar or plate.

Charging the aluminum bar or plate to some potential is no problem. High-voltage power supplies can be built with variable outputs. Cockcroft-Walton multipliers can raise the output of a medium voltage power supply to extremely high levels. Notice we're talking voltages, so the bar must be insulated from ground or it won't stay charged. If you're going to raise the bar to some high-voltage potential, it also needs to be insulated from the user. If the object you're trying to attract is grounded (uncharged) you have a problem. Either it won't be attracted, or the familiar static discharge will occur. If everything could be insulated and charged appropriately, there's the other problem already mentioned by Katznelson.

He's correct that electronic air cleaners use high-voltage fields. The charged dust and smoke particles are attracted to counter-charged plates or grids. The mass of those particles is very small, as is the mass of individual toner particles used in a copier. The strength of the field (voltage) is tailored to the working distance and the size of the particle. A copier might use 6-15 KV for even these small particles at close distances (1/4"). Extrapolating that to greater distances and larger particles, or even objects, and the voltage needed gets quite large, and would result in an extremely hazardous, or even lethal, device.

Richard M. Nelson
Newport News, VA
nelson@jlab.org

ANSWER TO #11965 - NOV. 1996

At one time, I too wanted to sepa-

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
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- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
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- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
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rate the video CCD circuitry from a Fisher Price kiddie camcorder. After opening the unit up, I found two PC boards. A smaller board held the CCD chip and a few support components. It was connected to a larger PC board via a short 10-conductor ribbon cable. Because the CCD board requires circuitry found on the larger board, separating the two was not possible. I was, however, able to unsolder and replace the short interconnecting ribbon cable with a two-foot ribbon cable. This cable extending should work to a maximum of three feet — any longer and RFI

Continued on page 117

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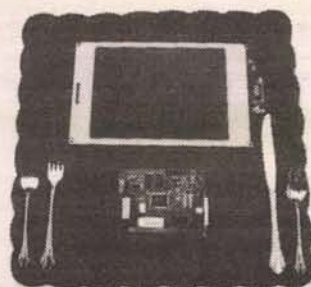
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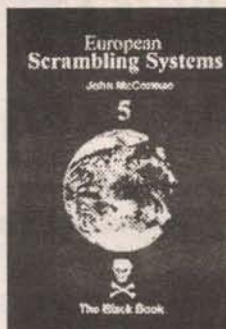
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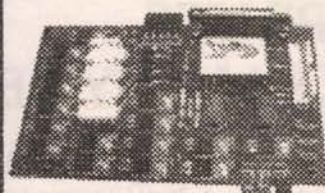
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SWITCHING POWER SUPPLIES \$12.00 or 2 for \$20.00 115/230 Volts

73 WATT (2) 4 pin power connectors attached • Dim: 8.5" L x 4.5" W x 2" H

Output: +5V @ 2-9.75 A, +12V @ 0-1.5 A, -5V @ 0-0.4 A, -12V @ 0-0.5 A

68 WATT Dim: 5.5" L x 3.2" W x 1.7" H • Output: 5V @ 4 A, 12V @ 4 A

60 WATT Dim: 8" x 4" x 3" • Output: 5V @ 6 A + 12V @ 1 A - 5V @ 1 A - 12V @ 1 A

CHARGE COUPLED DEVICES



"The Spy In The Sky" \$79.⁰⁰

MATRIX TYPE

Thomson 576X550 pixel CCD

400-1,100nm resolution and responsivity. \$500⁰⁰ Original cost device

Sony CCD Imager - designed for black and white composite video cameras. Picture elements: 384 (H) x 491 (V) \$29.⁰⁰

Chip size 10.7 (H) x 9.3 (V) mm² • Unit cell size 23.0 (H) x 13.4 (V) um².

Ceramic 24 pin DIP package • Mfr: Sony, Part# 016AL

4096 element CCD \$19.00

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1024 element CCD \$15.00

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Order desk only: **USA: (800) 872-8878 CA: (800) 223-9977**

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OEM INQUIRIES WELCOME

MONITORS

Non-Enclosed TTL

Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15KHz. • Ability to do 40 and 80 column.

5 inch Amber \$29.00 • 7 inch Amber \$39.00

9 inch Amber or Green \$29.95

5" COLOR MONITOR \$49.⁰⁰

• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible

• 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq.

• Open Frame Construction • Standard Interface Connector • Degaussing Coil included • Mfr. Samtron

9" monochrome SVGA MONITOR \$99.⁰⁰

Tilt and swivel type. Mfr: WEN

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ADAPTEC 4070A (RL) OR 4000A (MFM), SCSI Controller, your choice \$25.⁰⁰

IBM 370 option XT and AT emulation boards \$35.⁰⁰

HACKER CORNER

US made Micronics 486 VLB ALL in ONE \$99.⁰⁰ or 2 for \$159.⁰⁰

motherboard, supports 3.4 or 5V CPU, at either 25 or 33 mhz basic clock. Can use AMD or Intel from 486SX25 thru 486DX4-100 to HOT new AMD 5X86-133 cpu. On board SVGA video. On board 1 meg video ram expandable to 2 meg with ATI Mach 2 chip set. On board 2 high speed serial ports, 1 printer port, floppy and IDE hard drive controller. On board 256K cache. Uses 72 pin simm memory. Landmark speed rating of 479 with AMD chip.

Board will not fit standard AT in One case because of non standard location of riser board. VLB riser board is included with motherboard.

CAMERA BLOCK \$99.⁰⁰ or 2 for \$169.⁰⁰

FOR ROBOTICS AND EVERYTHING ELSE

Unit is for Hi Band 8mm CamCorders, includes 8X zoom lenses, D/D converters, built-in CCD 2/3 in, 420 thousand picture elements, complementary mosaic filters. Excellent performance. High resolution, high sensitivity, low lag, low smear, good color reproduction, no distortion, 1/60-1/10000sec variable speed digital shutters, TTL auto focus, auto white balance, one-push auto white balance, auto/manual iris and gain up switch. Can be controlled by a 4bit micro computer. Remote controlling is possible for zoom and focusing. NOTE: We have Composite or PAL (European Standard) Units. MFR: SONY

CELL SITE TRANSCEIVER \$79.⁰⁰ 2 for \$149.⁰⁰

These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 MHz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. Channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tuneable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Encased Black & White Composite CCD Camera with Adapter

IR viewing to 1000 nm 7 1/2" L x 2 1/4" W x 1 1/4" H

Comes complete with CCD camera, mounting nut on bottom of casing, 12VDC power supply. Excellent low light capability, standard RCA NTSC video out.

Great for: entryway security/remote monitoring, video conferencing/desktop video conferencing

This miniature camera is perfect for multimedia computer applications as well as security and surveillance. iTSC output allows use with all popular video digitizing boards for Apple Macintosh and Microsoft video for Windows. Connects directly to any composite monitor or VCR with "video" input. Its razor-sharp wide-angle lens focuses from two inches to infinity and its state-of-the-art CCD technology accurately captures 16 level grayscale images for Quick Time movies and still pictures. Records at 30 frames per second and 260 lines resolution with excellent low light capability. Uses 12VDC (adapter supplied) and standard RCA cable.

POINT OF SALE BANK TERMINAL \$49.⁰⁰ or 2 for \$89.⁰⁰

• LCD Display 20 Char. x 4 Line • Printer 16 Column Dot Matrix • Epson • 24 Key Domed Membrane Keypad • Intel 80C32 Processor • 2 PCMCIA Sockets (ICC Slots) • Dallas DS1287 Realtime Clock • 2 Solid State Buzzers (Piezo Electric) • 4 Crystals • Rockwell Modem Chip • Telephone Line Interface (4 Pin "RJ" Connector) • RS-232 Interface (8 Pin "RJ" Connector) • NI-CAD Battery Pack Inside
Note: We have not been able to bypass an access code in the software. Thus, while time of day and other introductory things are displayed on LCD, the full original capabilities of this unit cannot be guaranteed. Also, we do not have a source for the smart cards that were to go in the PCMCIA sockets. Requires 12 volt adapter for power. (Not included) Dimensions: 9-1/2 L x 6-1/4 W x 2-1/2 D • Original cost over \$450.00

.6" COMPOSITE MINIATURE COLOR DISPLAY \$149.⁰⁰

Fully encased. Dim: 1.3" x 1.3" x 4". 12 Volts DC power. NTSC signal. 250 H x 300 V resolution. Focus adjustable eyepiece. Applications include camcorder viewfinder, helmet mounted display, etc... Original cost over \$600.00

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TUNING IN LIFE-AND-DEATH RADIO CALLS

by Gordon West

Like a little excitement out there on the radio waves? Whether you have a scanner or simply a small shortwave set with a beat frequency oscillator or SSB switch, there are plenty of fingernail-biting radio calls going over the airwaves on a daily basis.

"This is Medic 47, and our patient just went into full arrest. He has a gaping hole... If you have a scanner, I'll tell you where to tune in the other side of those medic frequencies (that they usually don't publish) where you'll hear the excitement first-hand, and not simply a relay from a hospital base station radio nurse.

"Coast Guard Miami, we see three survivors hanging onto what's left of the sailboat keel. Wait a minute, Coast Guard, it looks like one of the survivors may be holding a... Did you know that a relatively inexpensive scanner or ham radio general coverage receiver can tune into the ship side of those long-range Coast Guard emergency frequencies? Instead of hearing the Coast Guard operator on a relay, you can actually tune directly into those stations on scene sending their emergency traffic.

And for those of you who tuned into VHF

with a constant data stream. Every day, lock out the specific channel carrying data, and then sit back and listen to some interesting excitement that sometimes stays on the same channels for each exchange of radio traffic, yet other times may jump around on several channels during the actual emergency call. 851 MHz to 869 MHz is sandwiched in between taboo cellular reception, and if your scanner gives you these frequencies, tune in for some excitement. Remember, what you hear over the scanner must be kept confidential, and you're not allowed to record it or to tell anyone else any type of radio traffic not directed to you.

Down on the 460 MHz band, you probably are hearing your municipal police department just above 460.000 MHz, and some of the excitement of car chases, bank robberies, and pursuits. But the life-and-death calls are carried on the eight "med channels." There are actually 16, and it's the "other eight" medical channels where you can pick up life-and-death excitement at its best (if there is anything "best" about someone ready to buy the farm!).

No doubt you have tuned in the paramedic hospital channels from 463.000 to 463.175 MHz, spaced every 25 KHz. You may have thought this is where the excitement is when you hear a physician interrogating a paramedic on another frequency about the status of the patient. But the real excitement is on the paramedic channels where you actually hear the medics in the field

with their portable units, or in route to the hospital with their medical radios hooked into an ambulance high-gain antenna. Listen 5 MHz up, and tune in the paramedics on the following frequencies:

468.000 MHz
468.025 MHz
468.050 MHz
468.075 MHz
468.100 MHz
468.125 MHz
468.150 MHz
468.175 MHz

You'll need an outside scanner antenna to pick up calls more than a mile away. Your maximum reception range will probably be within the radius of a five-mile circle to medics already hooked into an ambulance outside antenna system, or your range may be less than one mile when you are tuning them in direct at the scene of an accident or illness where they are only working off of the little rubber antenna on their UHF

communicator devices.

Sometimes, you'll actually hear the patient's heartbeat during the telemetry run from medic to hospital. And if you get real good at it, you can alternate between the hospital channel and the medic channel by scanning the 5 MHz split just between those two channels — i.e., medic channel 1 at 468.000 medic transmit, and 463.000 base station hospital transmit.

If you live near the ocean or a big lake, the United States Coast Guard can be heard on 156.800



Some ham radio two-meter channels may be reserved, during rush hours for road accident reports.

Channel 16 and 22A, 156.800 MHz and 157.100 MHz, you would have heard the live reports of the ocean off of Long Island that was set on fire by the TWA that plunged from the sky. "We see debris all around us, and wait a minute, we have someone spotted in the water, but we are having a hard time making out what we are looking at... The communications get more gruesome as the night wears on.

SCANNER ACTION

If you have a programmable scanner capable of VHF and UHF operation, plus selective coverage at 800 MHz, there is excitement all over the dial. Let's start from the top and work down.

Most scanners block out 800 cellular calls, but there are some pretty exciting legal-to-listen-to FM signals centered around 859 MHz. There is a small island of public safety frequencies that many fire departments and rescue units operate on over a trunked radio system. They usually are assigned a block of channels, with one channel rotating daily



Ham Radio operators passing important Radio Amateur Civil Emergency service calls in San Diego, CA.



Soon global positioning receivers can transmit your position automatically over the radio bands.

MHz, VHF Channel 16, international distress, or US Coast Guard on-scene working, 157.050, 157.075, 157.100, 157.125, 157.150, and 157.175. These "on-scene" VHF channels will let you hear both

sides of the conversation because they are simplex. Unlike the paramedic and 800 MHz duplex channels, these simplex frequencies will give you both ship, as well as shore, on the same frequency.

But on VHF Channel 16, 156.800 MHz FM, don't be surprised to hear someone screaming Mayday, only to announce that they are lost in the fog, and their mother-in-law is bent over the side feeding the fish. Only now and then can you tune into the real drama on Channel 16. That TWA crash was a good example of hearing all of the news, long before you saw it on the TV.

If you live in the boondocks, try these VHF mountain search and rescue special emergency frequencies:

155.160 (always busy with search and rescue activities)

155.175 MHz

155.205 MHz

155.220 MHz

155.235 MHz

155.265 MHz

155.280 MHz

155.340 MHz

155.400 MHz (life flight frequency)

Down on low-band scanning between 30 MHz and 50 MHz, you will need to check with your local ambulance company that sports a big 54-inch whip antenna to see where they are transmitting. Or maybe get one of those Optoelectronics frequency counters, and see exactly where they are transmitting. Lots of good FM excitement here. You might even look into hooking your scanner into your computer with Optoelectronics hardware and software, and keep a count on all that's happening when it comes to life and death out there on the VHF and UHF frequencies.

And you better do it now, because in about 10 years from now, most emergency radio communication traffic will go from analog to digital and you're going to miss out on some real exciting life-and-death calls that are easily received today with a simple programmable scanner. I wouldn't look at these medical emergency channels going digital within a year or so, but ultimately as more municipalities wear out their analog equipment, they very well might make the switch by the year 2005. And by then your new scanner and Opto programming intercept system will have brought you thousands of hours of cliff-hangers from the airwaves.

ON THE SHORTWAVES

While most of the major shipping companies throughout the world have switched from single-sideband shortwave over to digital INMARSAT communications systems, Global Marine Distress Safety System (GMDSS) regulations may still require that huge ships also carry single-sideband equipment and marine VHF equipment to stay in touch with smaller boats who can't put aboard a big motorized dish. Here again,

marine VHF Channel 16, 156.800 MHz, becomes a target frequency for any type of boat to howler Mayday.

Out on the high seas, the United States Coast Guard operates on several duplex pairs using conventional upper sideband:

4426 KHz	Coast Guard transmit
4134 KHz	Paired ship transmit

8764 KHz	Coast Guard transit
8240 KHz	Paired ship transmit

13,089 KHz	Coast Guard transmit
12,242 KHz	Paired ship transmit

These are the three main paired channels with the Coast Guard transmitting on 4426 KHz, 8764 KHz, or 13,089 KHz; and the vessel transmitting back to them on 4134 KHz, 8240 KHz, or 12,242 KHz. These are duplex channels where the Coast Guard and ships respond to each other in the same MHz band, with each transmitting alternately. (The 12 MHz and 13 MHz frequencies are considered within the same band.)

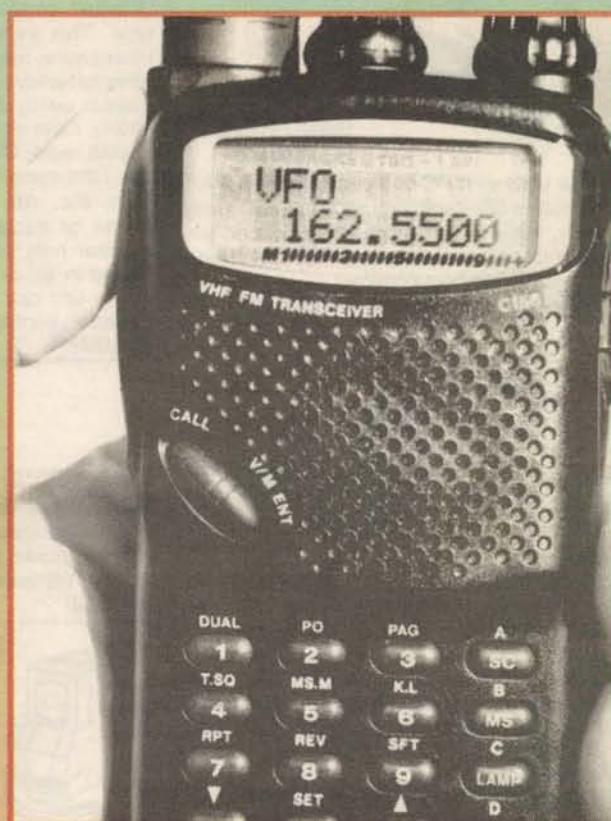
A simple shortwave receiver, capable of tuning in single sideband, or a ham set with general coverage receive for upper sideband, can be tuned into these US Coast Guard AMVER frequencies. AMVER standards for Automated Mutual-assistance Vessel Rescue System. This is where you will tune in those long-range, hair-raising distress calls between the Coast Guard, a big ship that might be providing the lifesaving, and a small sailing boat squawking Mayday with everyone bailing out in their life preservers.

Everyday more than 2,500 big commercial vessels worldwide participate in the AMVER safety network. The heart of the system is a computer-generated database, that last year plotted the voyages of more than 12,000 ships. The computer can, as requested in an emergency, dead-reckon the location of AMVER vessels in relation to a distress, allowing a little tiny sailboat to scream Mayday, and get their signals picked up by the Coast Guard, and the Coast Guard then relays this Mayday call via COMSAT to a big boat, and then the big boat comes up on the single-sideband airwaves, and rendezvous with the sailors.

This is the way it went for Joe Hess, a sailor caught in twin hurricanes and going down fast. You could easily pick up his SSB radio calls where he described water up to his knees, and in

imminent danger of sinking.

The Coast Guard assured him of a big military vessel in the area, with Hess thinking he's out there in the middle of the Pacific all by himself. As the hurricane abated, Hess scanned the horizon on radar and told the Coast Guard there was no one within 20 miles of him, and he was ready to go down within minutes. You could hear his single-sideband



Most ham two-meter sets can tune into radio calls well outside of the ham band limits.

shortwave radio call on the ship transmit frequency 8240 KHz, loud and clear. The Coast Guard repeated that the rescue vessel was within one mile of his location. Hess said no. The Coast Guard said get ready for evacuation.

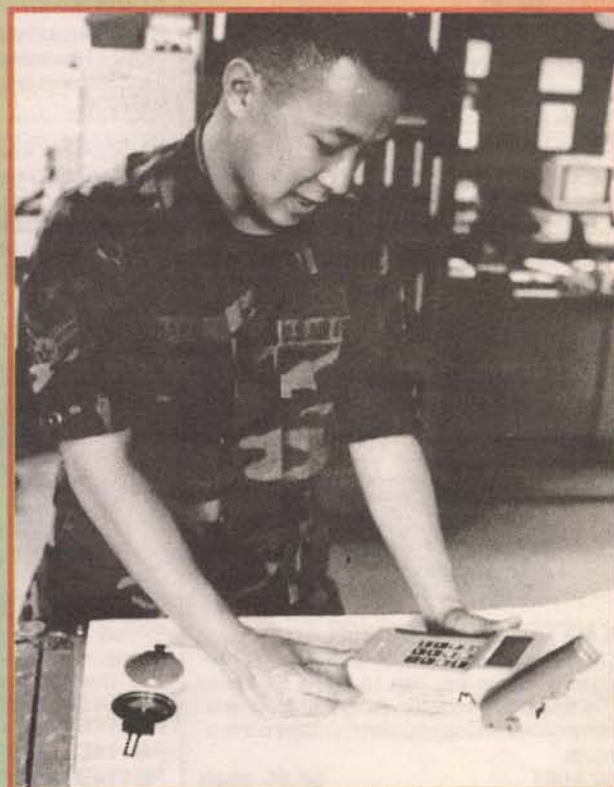
Five minutes later an ear-crashing signal comes over 8240 KHz "... Coast Guard Rescue Coordination Center, this is United States Navy submarine 1034... Joe spent a day on the sub, the Navy patched up his boat, and they departed each other the next day. The drama over the airwaves kept some shortwave listeners up for the entire night.

The United States Coast Guard also offers emergency medical advice over these AMVER frequencies. US Coast Guard doctors can be heard on the air relaying lifesaving instructions to vessels at sea. If it's a medical emergency that stumps them, a cooperative agreement with doctors in Cern, Rome, Italy, can be heard over the long-range frequencies.

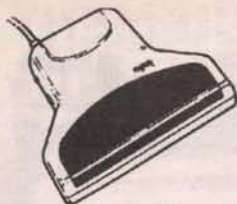
What you hear over the radio is considered directed traffic; and while there is no rule that prohibits you from tuning into these non-public correspondence frequencies (that are taboo to listen to), you are not allowed to divulge what you hear. Maybe I gave you too much information already in this article! But you get the idea — don't go into business tuning into these frequencies, and selling the information to a local news agency. Just enjoy the excitement of what you hear, and be darn glad you're not going through some of the trauma that the other folks are going through on the airwaves.

Outside scanner and shortwave antennas are a must to pick up these radio calls when you are tuning into the "unpublished" frequencies that are paired with the more common channels. Get yourself some scanning and shortwave frequency directories at your local Radio Shack store, and this will help you zoom in on additional life-and-death calls from other agencies.

It will be many years before the airwaves go digital. Until then, get those latest scanner gadgets from Opto, and enjoy life-and-death excitement BIG TIME! **NW**



Military emergency calls can be heard on both shortwave, as well as on your scanner.



Good!

HAND HELD SCANNER

New units with PC-compatible "Interpreter" Windows OCR software with imaging capability, 100-400 DPI resolution, LED and audible scanning speed indicators. 8-bit I/O card included. Requires Windows.

SC04-1 **Blowout Price! \$19.95**

Better!



800 DPI GREYSCALE HAND SCANNER

High-tech computer peripheral that is easy to use. Has support for TWAIN input devices and JPEG compression in addition to TIF, TGA, BMP, EPS, PCX and GIF. Even has commands to combine images or ports of images to create new images?! Painting tools, image processing filters, and transformation commands to help you modify an image or selected area.

Requirements: IBM XT/AT, or 100% compatible, 386 or higher recommended. DOS 3.1 or higher. Windows 3.x or Win95. 640 KB RAM, 2 MB RAM recommended. 5 MB available hard disk space, 15MB recommended.

Hmmm... I wonder what it can do for my old high school graduation picture.

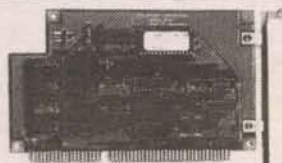
96C014 **\$59.95**



H-P IB CABLES

IEEE-488 interface.

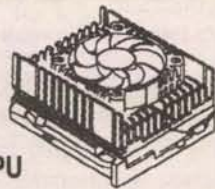
• 1 meter **96W008 \$ 9.95**
• 2 meters **96W009 14.95**



16-BIT IDE CONTROLLER

Hard drive only.

96C012 **\$2.99 each**



COOLING FAN FOR PENTIUM CPU

With Peltier device.

96C015 **\$44.95 each**



SUPER BRIGHT LIGHT BAR

Twenty very bright red LEDs mounted in a plastic reflector/lens housing. Measures 16.5" long by 1.2" wide. 12VDC @ 400mA operation. From auto brake light.

96L001 **\$4.95 each**

BOOM MIKE

Electret condenser type. This versatile microphone may be wired for handy-talkie, sound card, telephone, base station, aircraft radio, CB radio, motorcycle intercom, etc. An earphone or miniature speaker may be installed in either or both muffs. The microphone unit can be easily removed and installed on another headset or helmet.

92A001 **\$4.95 each**

KB6QWL



MULTIMEDIA MICROPHONE

Electret condenser mike element requires external power. Has 8-foot cable and mounting clip. 1/8" mono plug.

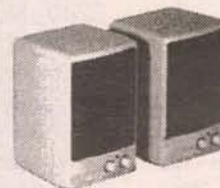
96V004 **\$1.95 each**



MINIATURE FOLDED HORN SPEAKER

8 Ohms impedance. Baffled box for better bass. Frequency response ± 6 dB, 120 Hz to 14 KHz. Use two in parallel for sound enhancement. Applications include multimedia (connects into sound card), ham radio (visor mount), etc. Measures only 3" x 4" x 1". Incredibly good sound for such a small speaker!

95V017 **\$1.49 each**



AMPLIFIED SPEAKER PAIR

These units have excellent audio for their small size (approx. 3" x 3" x 5") and are loud

enough, too. A 3.5mm stereo plug brings the audio in, and each speaker has its own volume control. They run on 6VDC (four "C" batteries) or an external 6VDC wall transformer. Cables included.

94V007 **\$9.95/pair**



STEPPER MOTOR DRIVER IC

UCN5804-B. Drives a unipolar stepper in one of three operating modes: single phase, two phase or half step. Up to 1.25 Amps per phase. Step and direction input. Drive with a 555 oscillator, parallel port, etc. Build your own robot turntable for model trains, anything that requires precision positioning.

93I002 **\$4.50 each**

• Above, packaged with 5V stepper motor (92M010) and schematics.

93I003 **\$9.95 each**

USED TUBES

Tested good - \$1.00 each

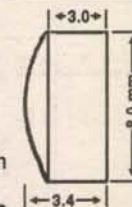
6AL5	6CB6	5814
6AX4	6SN7	5963
6BG6	12BE6	6005
6BK4	12SN7	6197
6BZ6		6211

Price Good Until 1-31-97.

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Better than Caller ID! This device detects an incoming call. If you subscribe to caller ID, the unit will automatically receive and display the caller's telephone number. If not, the unit will ask the caller to enter their telephone or personal ID number. The device will then display and compare this telephone or personal ID number to a memory bank of numbers that you've installed. If the system finds a match your phone will ring. If the system does NOT find a match, the caller will be directed to leave a message. All messages are digitally recorded. No tape or answering machine necessary. New, in factory cartons, with documentation.

96U001 **\$59.95 each**



SMALL GLASS PLANO-CONVEX LENS

8mm diameter, f=25mm, 3mm thick. Shown actual size.

96L006 **\$1.95 each**

RECYCLED DISKETTES

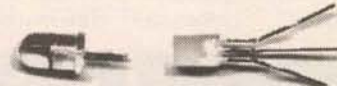
1.44Mb, erased, from unsold software.

95C017 **100 for \$19.95**

UHF LINEAR AMPLIFIER

For 870-895MHz, 45W output. 1 Watt input. VCC 20 to 30 VDC @ 6 A. Class A, low intermodulation distortion. New, with spec sheets.

96A003 **\$149.00 each**



LOW-POWER XMAS LIGHTS!

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SE5012G **69¢ each**

• EXTRA-BRIGHT RED LED - T1-3/4 size, 1000 mcd, 2VDC max at 45mA, water clear
SE5012H **59¢ each**

• ULTRA BRIGHT LED - T1-3/4 yellow, 2000 MCD.
SE5034H **69¢ each**

• BLUE LED - T1-3/4 blue water clear.
SE5064 **\$2.95 each**

• BI-COLOR LED - Red/green, 3 lead, common cathode 5/32" (4mm) square flat top.
SE5712ZC **75¢ each**



6 METER FSK RECEIVER

Crystal controlled on 50.675 receive frequency. Super het with 10.7MHz IF. Three ICs and one transistor. Not a kit! New, with schematics and spec sheet for major components.

92A067 **\$9.95 each**



LONGWAVE ULTRAVIOLET LAMP

This pocket-sized longwave ultraviolet light may be used for detecting invisible inks, minerals in rocks, etc. It's the size of a pocket pager and even has a belt clip to keep it handy. Runs on two "AA" batteries (not included). 3.25"W x 1.75"H x 1"D. Use with felt tip pen with UV/fluorescent ink (96L005).

95L007 **\$7.95 each**



SUPER INVISIBLE INK PEN!

Use our ultraviolet lamp (95L007) to easily see the mark you've made on your valuables. This pen makes a broader, easier-to-see, mark than other UV pens.

96L005 **\$4.99 each**



HI-SPEED STEPPER MOTOR

Ball bearing, 6 wire, 0.9°/step (400 s/rev). Size: NEMA 17, 1.625" square x 0.75" deep. 5mm x 1cm shaft. 12 VDC, 1A motor, 12 Ohm coil. Made by Japan Servo.

95M006 **\$4.95 each**



13.8 VDC REGULATED POWER SUPPLY

Rated 5A continuous, 7A maximum. Features include illuminated on/off switch, fuse, binding posts and cigar lighter socket.

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Five pounds of assorted electronic hardware - fasteners, nuts, bolts, screws, brackets, springs, standoffs, arms, gears, pulleys, and indescribable metal stuff scrounged from Silicon Valley's surplus to complement your hardware hoard.

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TEST EQUIPMENT cont.

TEST EQUIPMENT SALE: Anritsu optical TDR, MW98A, with MH925A plug-in, \$2,500; Biomation K100D complete with probes and grabbers, \$750. Dranetz 305 phase meter with plug-in 2Hz to 700kHz, \$350; Racal Dana 9009N portable FM/AM modulation meter \$350; Wavetek 5820B cross channel spec. analyzer, \$1,850; Tek FG 5010 prog. function generator, \$750; Tek PS 5010 prog. power supply, \$650; Singer Stoddart NM-65 1-10 GHz field strength meter \$1,200; Coppes Electronics, 30-day warranty. 520-749-8471, Fax 520-760-7780. Visa and MasterCard accepted.

SCOPES & PLUGS. Tektronix R5111 storage mainframe \$275; R7603 100MHz frame \$150; 7613 or R7613 as new 100MHz storage mainframe \$275; R7704 250MHz frame \$200. **SC-504** 80MHz scope as new \$375. 7A16A \$50; 7A18 \$50; 7A16P \$100; 7A19 \$100; 7B50 \$65; 7B53A \$85; 7B80 \$100; 7B85 \$85; 7B87 \$200; 7B92A \$150. 7D12 \$100, 7D15 \$250; TEK 7612 \$150. DC-501 option 1 \$175; DC-505A \$200; DM501A \$175. DM502 \$175. **PG-502** 250MHz pulse generator \$300; PG-508 pulse generator \$400; TM-501 \$100; **PULSE INSTRUMENTS PI-451A** programmable pulse driver \$100. **Psitech Plus** 707-745-4804 request bi-monthly fax listings. Fax 707-747-5277.

PORTABLE SCOPES: Tek 465 (100MHz) \$425. Tek 465B/DM44 (100MHz, multimeter) \$590. Tek 475A (250MHz) \$675. Tek 466 (100MHz, storage) \$750. All with bright CRTs; excellent condition, warranty. Pepper Systems, 214-353-0257.

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HP 141T, 8555A, 8552B, \$2,000; HP 141T, 8554B, 8552B, \$1,800; HP 8553B, \$500; HP 8660A, \$250; HP 86290A, 2-18 GHz, sweep plug-in, \$1,800; HP P532A, wavemeter, \$150; Scientific Atlanta programmable microwave receiver, with digital phase gain meters, phase meters, \$2,500; Fluke 332B voltage calibrator, \$600; HP 3320B, \$400; HP 3330B, \$500; Rockland 5100 synthesizer, \$400; HP 334A, distortion ana., \$450; HP 332A, \$300; HP 331, \$250; Send for test equipment sales list. A-Comm Electronics, 7198 S. Quince Street, Englewood, CO 80112. 303-290-8012.

ATTN: TELECOM transmission engineers. For sale: HP AC voltmeter model 403B 1mw, 600 ohm. \$100 OBO. 714-494-0072.

ELECTRONIC TEST EQUIPMENT BOUGHT & SOLD

Alitech 360D11, Frequency Syn., 01-2GHz	\$1,000	HP 8660B/100, Synth. Freq. Gen. Mainframe	\$800
Anritsu ME645A, Microwave Radio Test Set	\$1,000	HP 86601A, RF Plug-in, 110MHz	\$250
Arbiter 1040A, Meter Calibrator		HP 86602B, RF Plug-in, 1300MHz	\$600
AC/DC/Voltage/Current	\$1,200	HP 86603A, RF Plug-in, 1-2600MHz, Opt. 02	\$1,500
Argosystems AS210, Frequency Calibration System	\$3,500	HP 86632B, Modulation Plug-in	\$400
Balco 911A, Frequency Response Analyzer (unused)	\$400	HP 8683A, Signal Gen. 2.3-6.5GHz, Opt 1, 2	\$1,500
Ballantine 1627A, Scope Calib., with vac. heads	\$1,000	HP 8684B, Signal Gen. 5.4-12.5GHz	\$2,000
Boonton 25A, Power Meter Calibrator	\$350	HP 8750A, Storage Normalizer	\$250
Boonton 4200, Power Meter, w/Detector, 100kHz-18GHz	\$800	HP 8821A, Medium Gain Bank Amp	\$150
Boonton 42BD, Microwattmeter 2MHz-7GHz	\$300	Ithaco 393, Lock-in Amplifier	\$300
Boonton 518-A4, Q Standard	\$250	Keithley 261, Pico Amp. Source (unused)	\$300
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1.2GHz, HPIB	\$650	Keppo ATE-100-1M, Power Supply, 0-100V, 0-1 amp (new)	\$200
Boonton 92A, RF Millivoltmeter w/Probe	\$300	Leeds & North 1091, Capacitor Decade, .001uF-1uF	\$150
Bruel & Kjaer 1612, Bandpass Filter	\$250	Marconi 2955, Radio Comm. Test Set, OCXO	\$4,500
Bruel & Kjaer 2107, Frequency Analyzer	\$200	Micro-Tel SG800, Sweep Signal Generator, 1-18GHz	\$1,000
Bruel & Kjaer 2305, Level Recorder	\$250	Narda 7000A/7202/7206, Microwave Multimeter, .01-18GHz	\$1,000
Cushman CE24B, Frequency Selective Voltmeter	\$800	Narda 792FF, Attenuator, 2-12.4GHz 0-20dB	\$100
Cushman CE-6030, Com. Monitor, with Opt. 05, HPIB	\$4,500	North Ali 540/10, Resolver Synchro Bridge	\$600
Datron 1062, Digital Multimeter	\$650	Phillips 3211, Scope, 15MHz 2Ch.	\$200
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DR Thiedig MILLI-TO2, Ohmmeter, 1 Milliohm-2 Terraohms	\$400	Polarad 1105 E-L, Sig. Gen., 1020A Mod., 8-2.4GHz	\$300
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Opt. 01, 03, 183	\$2,500	Polarad 640, Spectrum Anyz., 18GHz, Dig. Storage	\$1,400
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ESI 296, Auto LCR Meter	\$650	Racal Dana 1515, Delay Pulse Generator	\$500
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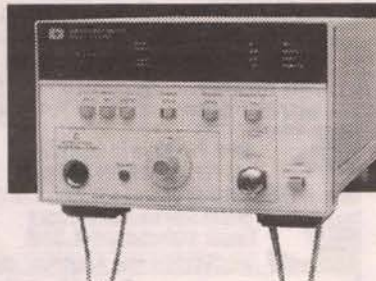
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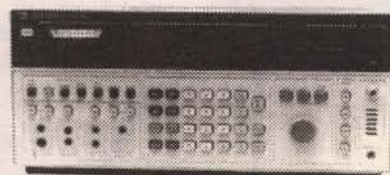
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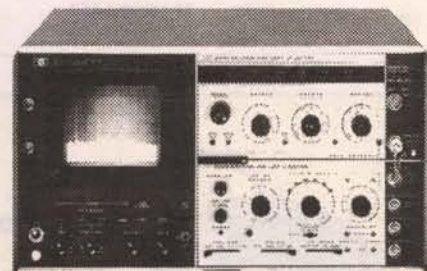
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Stamp Applications:

Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips

by Scott Edwards

The button instruction offered by both of the BASIC Stamps makes it easy to interface one or two buttons to your project. But if your application requires more sophisticated input, a keypad is almost a necessity. Button doesn't do keypads. This month, we'll look at a typical keypad and write a general-purpose BS2 subroutine for reading it. In BASIC for Beginners, we'll use Boolean logic to craft an elegant three-lane race timer demo with the BS1.

Scan a Keypad with the BS2 for Pushbutton User Input

16-key matrix keypad software, plus beginner's race-timer project

Matrix Keypad

Figure 1 is a 16-button keypad made by Grayhill and sold through Digi-Key (*Sources*). As the circuit shows, a keypad is more than just a bunch of buttons bolted to a panel. It's a matrix arrangement designed to minimize the number of I/O lines required to read the buttons. Ordinarily, reading 16 button states would require 16 inputs. By arranging the buttons into rows and columns as shown in the figure, we cut the number of pins to eight. This savings in hardware requires some additional software — a keypad scanning routine.

The duties of keypad-scanning code are:

- To determine whether or not a key is pressed.
- If a key is pressed, to determine which one.
- To notify the rest of the program that keypad input is available.
- To avoid registering more than one input for a given keypress.

Although that sounds like a lot, a keypad scanning routine can be quite compact, as Listing 1 shows.

The keypad scanner is a systematic search. It starts with all connections to the keypad set to input. The pins are set high (1) by pull-up resistors. The object of the search is to determine whether one of the rows of the keypad is shorted to one of the columns. The scanner outputs a 0 to one of the rows, then looks at the column inputs to see whether that 0 shows up. If not, it turns off that row output and tries the next row.

When the scanner does find a 0 on a column input, it can easily determine which key is pressed using this logic: If we number the keys from top-

left to bottom-right, the first row of keys consists of 0, 1, 2, 3; second — 4, 5, 6, 7; third — 8, 9, 10, 11; and fourth — 12, 13, 14, 15.

So the key number is (4 x row) + column. Of course, that orderly numbering of the keys does not match the labels on the keypad itself, which is scrambled to conform to the arrangement of a phone keypad, but a look-up table takes care of that.

That's the core of the Listing 1 keypad scanner. There are some other subtleties:

- The scanner uses the NCD operator to convert the column bits into a bit position. For example, suppose the column bits are arranged with the 0 in bit 2, %1011 (% is the PBASIC symbol for binary numbers). The program inverts %1011 to 0100 using the logical-not operator (~). Then it applies the "priority encoder" operator NCD, which returns the bit position plus 1, which is 3.

- The NCD write-up in the current BS2 manual is wrong. It indicates that NCD returns the bit number, 0-15, of the highest bit position of a value that contains a 1. If the value doesn't contain a 1 in any bit position (value = 0), NCD is supposed to return 255. However, NCD actually returns 0 for a input value of 0, and 1-16 as the highest bit position containing a 1. That's why the program subtracts 1 from the NCD result before computing the key number.

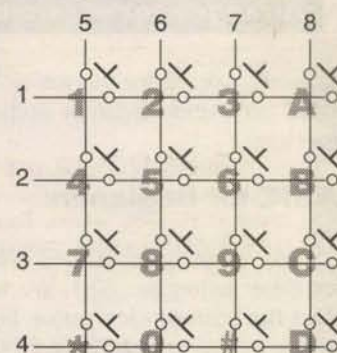
- Efficiency-minded programmers might be wondering why I used separate program lines to invert the column bits and compute their NCD. Why not do 'em both with one expression: `NCD ~col?` Try it. The program won't work. The reason is that PBASIC2 does all of its math and logic in a 16-bit workspace. Only when the result is written to a variable are the extra bits trimmed off. Consider what happens when you invert a four-bit number like %1011 in a 16-bit workspace. First, the number is converted to its 16-bit equivalent, %0000000000001011. It is inverted to %1111111111110100. Then the NCD of this value is computed, yielding 16. But the answer we expect is 3, based on the four-bit value %0100. To get the correct result, we have to trim off the additional bits, either by ANDing the intermediate result with %1111, or by simply writing it into the four-bit variable. I chose the latter, because it

1 2 3 4 5 6 7 8

Figure 1. Typical matrix keypad.



Grayhill Keypad
(DK: GH5003-ND)



Equivalent Circuit
1-4 rows; 5-8 columns

seems clearer to me.

- The scanning routine uses a bit variable, `db`, to debounce the keypad input. Debouncing prevents multiple responses to a single keypress by setting some condition for registering a new press. In this case, the condition is that the previously pressed key must be released before a new press will register. You can test this by holding a key down — only one response will appear on the Debug screen.

- Another bit variable — `press` — is used to tell the main program that the scan routine has detected a keypress. It's the program's responsibility to clear this bit once it has processed the input.

- Finally, a hardware note: In Figure 1, there are resistors in series with the lines to the keypad. These are not strictly necessary; they are just a precaution against static damage. If you are just bench-testing the circuit, feel free to omit them. But if you are building a device that will be used in the

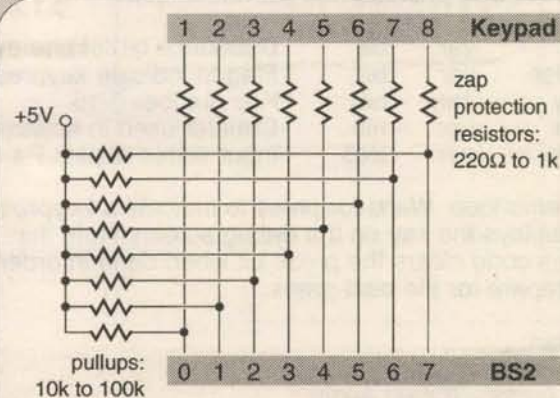


Figure 2
Hook-up for Listing 1

Stamp Applications:

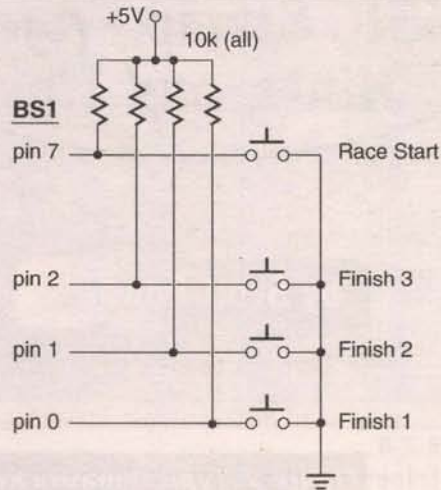


Figure 3
Arrangement of race-timer switches.

real world, spring for the resistors. They are cheap, partial protection against static zaps from users' fingertips.

BASIC for Beginners

Last month, we started work on a three-lane race timer using the BS1. We wrote some code to detect the start-of-race pulse, but ran into difficulty with maintaining independent timing on the three lanes while reliably detecting an end-of-race condition. After exploring some blind alleys, we concluded that the solution might be to keep a record of each car's status in terms of "in-the-race" or "finished." If a particular car is in the race, then we update its elapsed time, otherwise we stop the timer on that car. If all cars are finished, the race is over.

To save you the trouble of dragging out the previous issue of *Nuts & Volts*, Figure 3 once again shows the race-timer switches.

Now that we have a logical way to keep times and detect the end of the race, let's see how our ideas translate into a BASIC program. Let's start with variables.

First, we need to decide how to store the cars' times. We can choose from three storage sizes: bits (0,1), bytes (0-255), or words (0-65535). Clearly, bits are not suitable for storing race times, so the choice is between bytes and words.

It would be nice to base the decision on some hard facts, like the timing resolution in units/second and the maximum length in seconds of a race. For example, if races last 10 seconds or less, and timing resolution is 1,000 units/second, then we need variables that can hold values up to 10,000.

At this point, though, we don't know what our timing resolution might be. A stock BS1 executes about 2,000 instructions per second; a quad-speed Counterfeit, about 8,000. It will certainly take several instructions to keep time and detect the end-of-race, so we'll estimate a maximum of 2,000 units/second at quad speed. At that rate, a byte variable would give us a maximum racing time of $255 \times 1/2000 = 0.12$ seconds. A word variable would provide $65535 \times 1/2000 = 32.7$ seconds. So, the race timers will be word variables.

How about race status? We really need only two conditions: Racing and finished. That's an ideal job for bit variables. We can use a 1 to represent racing and 0 to represent finished.

Next, we need to determine how these variables will work together. Without writing any

Sources

For more information on the BASIC Stamp, contact:

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real code, let's sketch the main loop of the program. (I'm using a different typeface to indicate that this is not PBASIC, but pseudocode, a sort of pidgin-English/BASIC):

Timing:

Get state of Finish switches

Update racing/finished status bits

If status1 = racing, then increment time1

If status2 = racing, then increment time2

If status3 = racing, then increment time3

If status1=done AND status2=done AND...

...status3=done then Finished, else goto Timing

Finished:

Report race times

Seems like a lot of If...Thens. Thinking about

Listing 1. BS2 Program to scan a 16-key matrix keypad

' Program: KEYP.BS2 (Scan a 16-key matrix keypad).
' This program shows how to scan a 4x4 matrix keypad using a BASIC Stamp II (BS2). A subroutine scans the keypad when it is called. On return, a flag bit (press) will contain a 1 if a key was pressed, and a nibble variable (key) will contain the key number (0-15). Once the program has responded to a key press, it must clear the press bit to prevent multiple actions triggered by the same key press. In a similar way, the keyScan subroutine uses another bit, db, to avoid responding to a key press until the key previously pressed has been released.

db	var	bit	' Debounce bit for use by keyScan.
press	var	bit	' Flag to indicate keypress.
key	var	nib	' Key number 0-15.
row	var	nib	' Counter used in scanning keys.
cols	var	INB	' Input states of pins P4-P7.

' Demo loop. Waits for press to indicate a keypress, then displays the key on the debug screen. Note that this code clears the press bit when done in order to prepare for the next press.

```
again:
  gosub keyScan
  if press = 0 then again
  debug "key pressed = ", hex key,cr
  press = 0
  goto again
```

```
' ===== KEYPAD SUBROUTINE =====
' This code scans a 0 across the row connections of the keypad,
' then looks at the column nibble to see if that 0 has shown up
' on any of those bits. If the column bits are all 1s, then
' no key is pressed. If a column bit is 0, then a key is pressed
' at the intersection of the current row and that column.
```

keyScan:

for row = 0 to 3

low row

key = ~cols

key = NCD key

if key <> 0 then push

input row

next

db = 0

return

' Scan rows one at a time.

' Output a 0 on current row.

' Get the inverted state of column bits.

' Convert to bit # + 1 with NCD.

' No high on cols? No key pressed.

' Disconnect output on row.

' Try the next row.

' Reset the debounce bit.

' Return to program.

push:

if db = 1 then done

db = 1: press = 1

key = (key-1)+(row*4)

' Already responded to this press, so done.

' Set debounce and keypress flags.

' Add column (0-3) to row x 4 (0,4,8,12).

' Key now contains 0-15, mapped to this arrangement:

```
'   0  1  2  3
'   4  5  6  7
'   8  9 10 11
'  12 13 14 15
```

' A lookup table translates this to match the actual markings on the key caps.

```
lookup key,[1,2,3,10,4,5,6,11,7,8,9,12,14,0,15,13],key
done:
```

input row

return

' Disconnect output on row.

' Return to program.

Stamp Applications:

the status bits, they are going to contain 1 for racing and 0 for done. What if we change that to:

Timing:

Get state of Finish switches

Update racing/finished status bits

time1 = time1 + status1

time2 = time2 + status2

time3 = time3 + status3

If status1=done AND status2=done AND...

...status3=done then Finished, else goto Timing

Finished:

Report race times

Adding the status bit to the race time accomplishes the same thing as using the status bit to decide whether or not to add 1 to the race time. And it's a heckuva a lot simpler.

Now, what about those vague phrases regarding getting the state of the finish switches and updating the status bits? We need to translate those into something closer to BASIC.

The finish switches pulse low (0) briefly as a car crosses the finish line. The status bits must change from high to low when the corresponding finish switch pulses. The tricky part is that while the finish switch may return high, the status bit must remain low after the car has finished. We need the logic equivalent of a trap door that can go from 1 to 0, but not from 0 to 1.

Sounds like a job for AND (&).

In column 14 (available from the *Nuts & Volts* Internet library), we discussed the Boolean logic operators, including AND. Here's how AND works:

AND (symbol: &)

first bit	second bit	result
0	0	0
0	1	0
1	0	0
1	1	1

AND is just the trap door we need. During the race, a car's status bit is 1 and its finish switch is

1. AND 'em together and you get 1. Write that back into the status bit. When the car crosses the finish line, the status bit is 1 and the finish switch is 0. 1 AND 0 = 0, which goes back into the status bit. Now the car is officially out of the race. After the car is completely across the finish line, the status bit is 0 and the finish switch returns to 1. 0 AND 1 is still 0, so the status bit remains correct.

That leaves just the final detail of determining when the race is over. Our pseudocode shows this as a compound If...Then instruction combining the states of the three status bits. Maybe this can be simplified, too.

Although PBASIC lets us use individual bit variables, those bits are also accessible as portions of a byte variable. For example, bit0, bit1, and bit2 can be addressed individually, or as the lowest three bits of the byte variable b0. There are eight possible states for those three bits, and all we need to do is identify one of them — the case in which all three bits are 0. If we ignore the other five bits of b0, when those bits are 0, the byte b0 is 0. So that complicated If...Then can be reduced to IF b0 = 0 THEN... provided we can clear the upper five bits of b0.

Once again, we can call upon the bit-clearing power of AND. If we AND b0 with a number that has 0s in the upper five bits and 1s in the lower three bits, we can zero out the bits that we want to

Listing 2. BS1 race timer (BASIC for Beginners)

```
' Program RACE1.BAS (Prototype three-lane race timer).
' This program shows how the BS1 (or Counterfeit) can
' be used to time a three-lane Pinewood Derby race
' without complicated IF..THEN programming. This
' program is a prototype; when the race is over it
' displays raw data on the PC screen via Debug. Later
' versions will convert the data to units (fractions of
' a second) and display them on a freestanding display.

SYMBOL time1 = w2      ' Word variable for lane-1 time.
SYMBOL time2 = w3      ' Word variable for lane-2 time.
SYMBOL time3 = w4      ' Word variable for lane-3 time.

SYMBOL start = pin7    ' Start-switch on pin 7; 0=start.

SYMBOL status1 = bit0   ' Status of lane 1; 1=racing, 0=done.
SYMBOL status2 = bit1   ' Status of lane 2; 1=racing, 0=done.
SYMBOL status3 = bit2   ' Status of lane 3; 1=racing, 0=done.
SYMBOL stats = b0       ' Byte variable containing status bits.

stats = %111           ' All cars in the race to begin.

hold:
if start = 1 then hold ' Wait for start signal.

timing:
stats = stats & pins & %111 ' Time the race.
if stats = 0 then finish   ' Put lowest 3 pin states into stats.
time1 = time1 + status1    ' If all cars done, then race over.
time2 = time2 + status2    ' If a car is in race (status=1) then
time3 = time3 + status3    ' increment its timer. If it's done
goto timing                ' (status=0) don't increment.
                             ' Loop until race over.

finish:
debug cr,"Checkered flag!",cr ' Race over.
debug time1                    ' Display results.
debug time2
debug time3
```

ignore.

And that's all we need to form the core of the race-timing application. See Listing 2 for a demo.

Next time, we'll clear up the loose ends of converting our race times to units and displaying race results. **NV**

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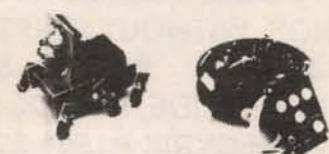
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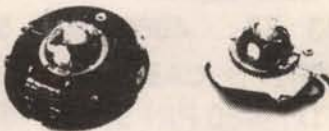
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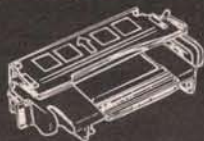
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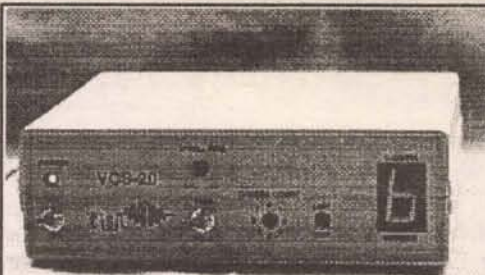
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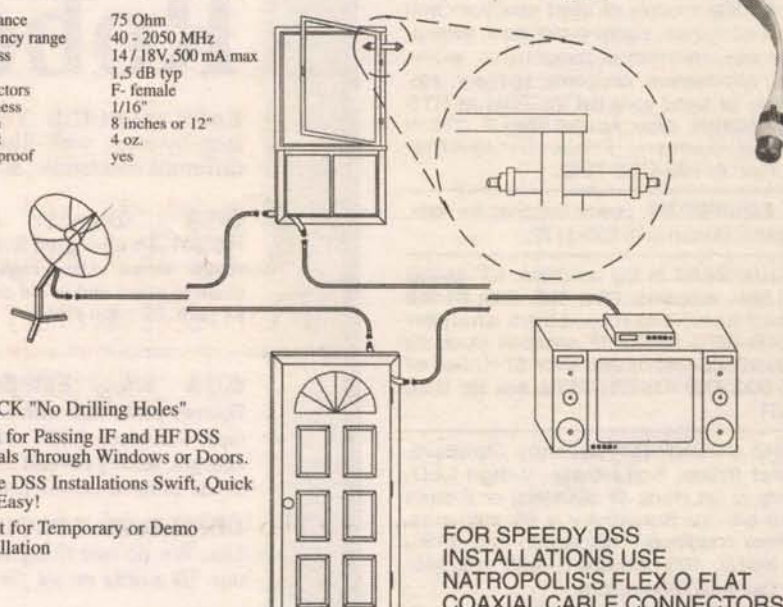
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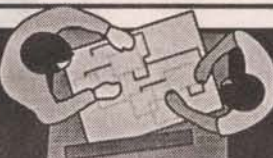
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Semiconductor Part Substitution

If you build electronic devices from magazine construction articles, or you repair electronic devices for yourself or others, you have run into the problem of part substitution. While this can be a small problem with common discrete components, it becomes a big problem to find equivalent parts for many transistors, diodes, and integrated circuits. Semiconductors are produced by many, many manufacturers all over the world, most with numbering systems unique to the manufacturer. This article will describe three major manufacturers that specialize in providing semiconductor parts substitution. They have huge data books and computer software that allow you to find equivalent parts.

and stuffing multi-sided printed circuit boards, have resulted in a huge decrease in size and increase in component density. Compact packaging has made it very difficult to access and test many parts at the discrete level. Much "repair" these days consists of simply replacing complete modules or circuit boards rather than tracing the problem to an individual component and replacing it.

Discrete Components

However, there are still many electronic equipment malfunctions that can be repaired with simple discrete components. Once it is determined to be the culprit, a burned resistor, or a shorted or open capacitor, can usually be unsoldered and replaced, even if mounted on a printed circuit board (PCB). Defining the requirements to replace the failed part can usually be determined by the size, shape, color code, or other markings on the failed part. The device schematic (if you have one) will tell you the proper value needed. Equivalent replacement parts for resistors, capacitors, relays, coils, etc., are commonly available from Radio Shack stores or regular electronic part distributors.

It is when dealing with semiconductors — diodes, resistors, integrated circuits, and other "solid-state" components — that you frequently find yourself facing the unknown. Literally tens of thousands of semiconductors with various characteristics are offered by dozens of large manufacturers around the world. How can you determine what transistor (for example) to use to replace the one that has failed?

Well, it turns out that vast numbers of semiconductors are so similar that several manufacturers each offer a reduced number of "equivalents" that cover a broad range of individual part requirements. In particular, in this article, we'll discuss the semiconductor replacements offered by NTE Electronics, Philips ECG, and Thomson Consumer Electronics. See the sidebar for addresses and phone numbers to contact for ordering information.

General Rules for Substitution

Whenever you need to replace a semiconductor, you can consider it safe

to replace it with a part having the identical part number and manufacturer. But this is often not possible. For one thing, it might be a foreign semiconductor not readily available from your normal parts source or, it might be an old part no longer manufactured.

This is when you are forced to look for a functional substitute — and this is where things can get difficult. Semiconductors have different critical characteristics, such as maximum voltage, current, power, and gain. Specific circuits can have certain critical requirements, such as frequency response, trigger current, linearity, power limit, gain, etc. What you need depends on your circuit application. Here are some simple rules to consider, as they apply in each case, when looking for a substitute semiconductor:

- * Use equal or greater breakdown voltage.
- * Use equal or greater operating current.

- * Use equal or greater power dissipation.
- * Use equal or greater gain bandwidth product.
- * Use equal or lower switching time.
- * Use equal or lower trigger current.
- * Use equal or lower reverse current.

Manuals and Disks

NTE (NTE Electronics, Inc.), ECG (Philips ECG), and SK (Thomson Consumer Electronics) parts are described in detail in thick manuals available for low cost from each of these manufacturers. In addition, each company offers computer disks with their database of available parts and their equivalents.

You'll probably need both the manual and the disk for each company whose parts you decide to use. While the disks provide very fast access to part number equivalents and limited specifications, you'll need the manuals for detailed specifications and pinouts.

The Old Days are Gone

Repairing radios 50 years ago was a relatively simple task. A burned out resistor, a leaky capacitor, a defective vacuum tube, a poor solder connection, or any of a number of other relatively simple problems, could be found quickly by observation or with a signal tracer (which was nothing more than a common audio amplifier) or a multimeter.

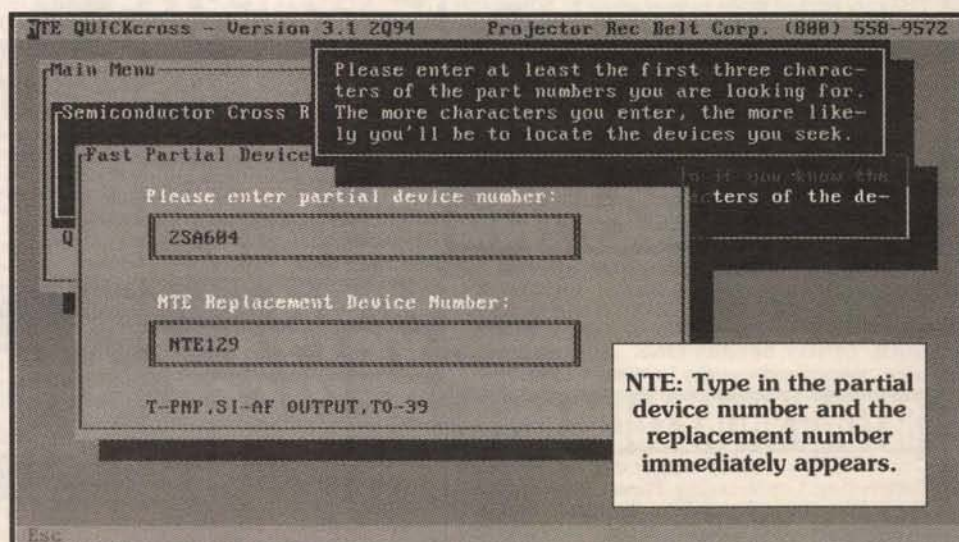
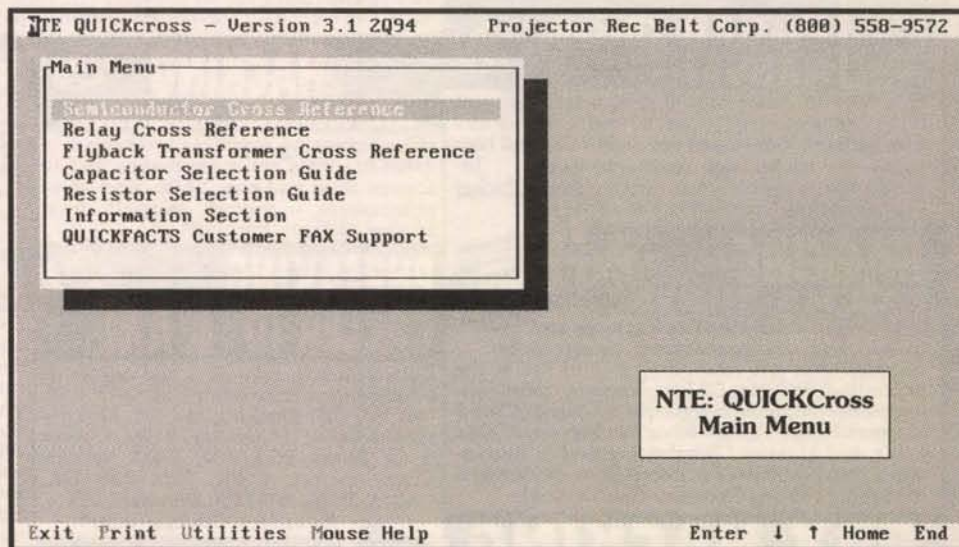
When television came along, things got more complex. Much higher voltages and more sophisticated circuits made an oscilloscope almost a necessity for troubleshooting. But, once the defective part or parts were determined, the actual repair still pretty much depended on a limited number of discrete components — tubes, coils, resistors, capacitors, etc.

Audio and video tape recorders added greatly to the complexity of repairs. They had more special circuitry, and many interacting mechanical parts with their associated wheels, gears, springs, belts, and sensors. In the last 20 years, computers, camcorders, VCRs, and all manner of electro-mechanical devices have come on the scene.

The Big Three Changes

Three major changes in electronics in the last 50 years have resulted in greatly increasing servicing complexity: printed circuitry, semiconductors, and miniaturization (including surface-mounted components).

The small size and enormous capabilities of semiconductors, together with the techniques developed in producing



The latest *NTE Semiconductors* (716 pages, \$4.95) covers 3,500 NTE semiconductors cross-referenced to over 250,000 US, Japanese, and European part numbers, including technical information. The computer database, "QUICKCross" is available on 5.25" or 3.5" diskettes for MS-DOS, and 3.5" diskettes for Windows. Contact NTE for current prices (around \$10.00). NTE also offers relays, resistors, capacitors, and fly-back transformers.

The latest (16th Edition) of *ECG Semiconductors Master Replacement Guide - ECG212R* (689 pages, \$5.95) covers nearly 4,000 ECG products, and features 276,000 cross-references. The computer database, *INSTANT CROSS Version 2.0* (MS-DOS), consists of three IBM PC 720K diskettes with a suggested retail price of \$11.00. ECG also manufactures many other electronic products, including capacitors, circuit breakers, test equipment, connectors, and surge suppressors.

The *SK Replacement Cross-Reference Directory* (784 pages, \$4.00) offers 3,600 replacements for over 235,000 parts, including NTE and ECG parts. The computer database, *SK Cross Version 3* (MS-DOS), consists of two 1.44 MB diskettes with a suggested retail price of \$5.00.

Since each of the manuals is intended to provide the same information about their line of semiconductors and the equivalents, they approach the task in similar manners, with slight variations. The diskettes that contain their databases come in 5.25" or 3.5" sizes with different densities and different prices. Contact each company for the details.

Using the NTE Manual and Database

NTE Semiconductors - 6th Edition has two tabbed parts: Technical Guide and Semiconductor Cross-Reference. The Technical Guide portion begins with an alphabetical and numerical product index section, then devotes several pages to replacement considerations, including handling and mounting techniques. This is followed by sections of data on various types of semiconductors: transistors; diodes/rectifiers; high-voltage devices; industrial rectifiers/bridges; SCRs/TRIACs; powerblock/hybrid modules; special devices; transient suppressors; IC protectors/thermal cutoffs; optoelectronic devices; voltage regulators; linear integrated circuits; digital integrated circuits; and microprocessors/memories. This is followed by sections on flameproof resistors, various types of capacitors, sockets, and heatsinks. Each of these sections includes dimensioned outline drawings and pinouts of each part, making this a valuable reference book.

However, it is the alpha-numeric Semiconductor Cross-Reference portion (over 300 pages in tiny print with seven columns per page!) that leads you to the NTE equivalent part numbers. You look up the part number you have and the NTE replacement part number is shown. Next you go to the Technical Guide numerical index to find the page number for a detailed description of that part and its operating characteristics, and the diagram number for the part dimensions and pinouts.

The *QUICKCross* database comes with installation and user instructions. We used version 3.1 for MS-DOS, but by the time you read this version 4 for DOS will be available, as well as a Windows version. We found the DOS installation of four 720K diskettes to the hard drive took only about five minutes, and occupied a little over three megabytes of hard disk space. You'll need 512K of free RAM and DOS 3.3 or better. Technical assistance, if necessary, is a phone call away. We had no questions, since the program ran very quickly and easily. The program runs in color, with no default to monochrome.

Using *QUICKCross* could hardly be easier. After a couple of initial information screens, you can select what you want from a Main Menu. The database on these disks includes not only semiconductors, resistors, and capacitors, but also has relay and flyback transformer cross-references. (Technical details and drawings on these last two are available in separate NTE manuals.) FAX support is also described.

If, for example, you want to know the NTE substitute part for a 2SA604 transistor, you can select "Semiconductor Cross-Reference" from the Main Menu, and you'll get a screen that will allow you to type in three or more characters of the desired search number. Almost instantly the screen will display NTE129 as the replacement, and will also indicate this is a PNP silicon transistor used for AF output and packaged in a TO-39 case. For further details, you would refer to the NTE Semiconductors manual. If there should be more than one replacement, another screen pops up with a list showing them.

The five cross-reference and selection choices on the Main Menu all work the same way. Simple. Fast. But you'll need the manuals for details - specifications, outline, pinouts - if you want those details.

The Information Section offers a short history of NTE Electronics, tells you how to get technical literature "for the asking," locates the NTE sales offices in your state or internationally, allows you to print out an Information Request Form, and even provides instructions and encouragement for you to COPY these disks and distribute them!

QUICKFACTS Customer Fax Support gives you the phone numbers and document numbers to "fax-back" the index to each of their product lines.

Navigation around the screens (which are all text-mode in the DOS version) is accomplished easily, and the Escape key gets you back if you head down the wrong path. Also you can print most screens very easily. In general, we liked this software better than the others tested. Very nicely done by Ed Prestwood at Cybersoft, Inc. (602-759-4849 in Phoenix, AZ).

Using the ECG Manual and Database

The *ECG Semiconductors Master Replacement Guide - 16th Edition* has a 368-page technical section, a 310-page cross-reference section, and 11

Monday
10/23/95
13:27:13

Thomson Consumer Electronics

SK Cross Reference System

Find SK Equivalents

Industry #	SK #	Description
2SA604	SK3715	PNP Si Transistor, FM AF Driver/Output,
2SA605	SK3715	PNP Si Transistor, FM AF Driver/Output,
2SA606	SK3025	PNP Si Transistor, AF Medium Pwr, TO-39,
2SA606K	SK3025	PNP Si Transistor, AF Medium Pwr, TO-39,
2SA606L	SK3025	PNP Si Transistor, AF Medium Pwr, TO-39,
2SA606M	SK3025	PNP Si Transistor, AF Medium Pwr, TO-39,
2SA606N	SK3025	PNP Si Transistor, AF Medium Pwr, TO-39,
2SA606S	SK3025	PNP Si Transistor, AF Medium Pwr, TO-39,
2SA607	SK3025	PNP Si Transistor, AF Medium Pwr, TO-39,
2SA607K	SK3025	PNP Si Transistor, AF Medium Pwr, TO-39,
2SA607L	SK3025	PNP Si Transistor, AF Medium Pwr, TO-39,
2SA607M	SK3025	PNP Si Transistor, AF Medium Pwr, TO-39,
2SA607N	SK3025	PNP Si Transistor, AF Medium Pwr, TO-39,
2SA607S	SK3025	PNP Si Transistor, AF Medium Pwr, TO-39,

SK: A list appears with your part number at the top, together with equivalent SK part and short description.

NTE QUICKCross - Version 3.1 2Q94 Projector Rec Belt Corp. (800) 558-9572

Industry Device Number	NTE Device Number	Device Description
2N2222	NTE123A	T-NPN, SI-AF/RF AMP, TO-18
2N2222A	NTE123A	T-NPN, SI-AF/RF AMP, TO-18
2N2222AJAN	NTE123A	T-NPN, SI-AF/RF AMP, TO-18
2N2222B	NTE123A	T-NPN, SI-AF/RF AMP, TO-18

NTE: Sometimes several related industry numbers are shown.

Esc Footnotes Main Menu Print

additional pages describing various other Philips products. The technical section begins with an alphabetical and numerical product index, then devotes six pages to replacement procedures, including handling, mounting, identifying, and testing techniques. This is followed by sections of data on various types of semiconductors: transistors (including surface mount); high-voltage devices; diodes/rectifiers; SCRs/TRIACs; special purpose devices; transient suppressors; crystals; opto devices; thermal cutoffs/IC protectors; industrial power modules, linear ICs; digital ICs; and interface/MPU ICs; accessories/heatinks. Each of these sections includes dimensioned outline drawings and pinouts of each part.

The over 300-page, small-print alpha-numeric cross-reference portion (seven columns per page) allows you to find the ECG equivalent part numbers. You must go to the technical section for a detailed description of that part's operating characteristics, diagram number, and pinouts.

ECG's *INSTANT CROSS* database comes on three 3.5" 720K diskettes with a small card describing the installation procedure. It takes about 10 minutes to install the diskettes onto your hard drive, and about 3.5 MB of hard disk space is used.

The program is extremely easy to use, and can be customized with your name and

address, as well as many color combinations, or displayed in black and white. The screens are all DOS text with borders. The Escape key quickly backs through the choices if you find yourself where you don't want to be.

After some introductory screens you are at the Main Menu where you can select finding the ECG replacement number, finding an ECG type description, printing the complete list of parts with abbreviated descriptions (about 250K!), or go to a Utility Menu. Finding a replacement number is as simple as typing in three or more characters and hit-

SOURCES

Call the following manufacturers regarding prices and ordering information for their cross-reference manuals and disks:

NTE Electronics, Inc.
44 Farrand Street
Bloomfield, NJ 07003
800-631-1250
800-683-6837

Philips ECG
112 Polk St.
P.O. Box 309
Greeneville, TN 37744-0309
Customer Service: 800-233-8767
(Will refer you to your local dealer.)

Thomson Consumer Electronics
2000 Clements Bridge Road
Deptford, NJ 08096-2088
Customer Service: 800-635-2474
(Will refer you to your local dealer.)

PHILIPS ECG MASTER GUIDE CROSS REFERENCE (C)Copyright 1991, 1994
Serial # 3234691

1 of 1
Part # ECG Replacement

2SA684	129
--------	-----

ECG: All ECG replacements are shown on a list.

ECG Replacement Description
129 - T-PNP, Si, AF Preamp, Dr, Vid Amp, T0-39

ESC - Exit F1-General Note F4-Print Part ↑ ↓ PgUp PgDn

ting the Enter key; the replacement number or numbers pop up almost instantly. At the bottom of the screen is a short description of the highlighted item. You can print the description of the highlighted number by just hitting the F4 key. For further details (specifications, pinout, dimensioned outline drawing) you must refer to the *ECG Semiconductors Master Replacement Guide*.

The Utility Menu choice allows you to select either color or monochrome monitor, making the program compatible with older monochrome desktops and laptops. If you have a color display, you can choose from eight foreground, background, highlight text, and highlight back-

ground colors. Another nice feature is that you can minimize the start-up time each time you run the program by shortening the display time of the initial screens.

Using the SK Manual and Database

The *SK Replacement Cross-Reference Directory* (last edition is dated 1992) starts with a subject index followed by an alphabetical and a product index, then a competitive cross-reference to Philips ECG and NTE products. This is followed by technical sections on SK: transistors; rectifiers; thyristors; optoelectronics;

integrated circuits; telecommunication circuits; CMOS/MOS/NMOS/PMOS; high-speed CMOS; DTL and TTL logic; microprocessors and memories; flameproof resistors; hardware; sockets; heatsinks; accessories; and voltage regulators. An exact semiconductor replacement guide precedes the main cross-reference of equivalent replacement parts.

Thompson's *SK Cross* program comes on either 5.25" 360K or 3.25" 1.44 MB diskettes. We used the latter, and had no trouble installing the program on our hard drive in less than 10 minutes — although the program expanded to almost 12 megabytes of hard drive space during installation. You must have at least 310K of free conventional memory, a very modest

requirement.

SK Cross was incredibly fast and easy to use. There is no main menu. You just type in 1 to 10 of the first characters of the desired part number and the screen instantly displays a sequential list of 14 industry part numbers. The list starts with the characters you entered, or the next industry part number in the database. You can scroll up or down the list to other nearby part numbers.

On each screen line you see the industry part number, the SK equivalent part number, and a short description. Highlight the line you want, hit Enter, and the screen displays additional information on that SK part. However, for detailed

specifications, outline drawings and pinouts, you must refer to the cross-reference directory.

If you start the program by typing "TCE" (no doubt for "Thomson Consumer Electronics"), the program displays in color. If you start with "TCE M" the program displays in monochrome, making it usable with older desktop and laptop computers. There is no special provision to print out results, but you can simply press the "Print Screen" key on your keyboard to print any screen in text and borderline characters. The screen reverse highlighting is ignored.

Do You Need the Disks?

Although the software is handy for finding numbers fast, you still may need to refer to the thick manuals for specifications, pinouts, and outline drawings to choose a replacement part for your particular use. If you have a frequent need, such as working at a parts house where you supply substitute parts to local electronic technicians, the software will get you a fast replacement part number, but you may still have to refer to the company's cross-reference directory for the physical package and technical limitations of the replacement part.

The manuals are extremely useful references, and NTE, ECG, and SK parts all will do the job, properly chosen. When it gets down to the bottom line, the specific electronic application and your judgment make the difference between a proper or marginal replacement. **NV**

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 - batteries included
 - jumper cable included
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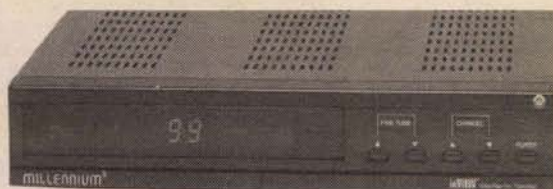
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Units sold with wireless remote control & batteries. Features include: parental control (Panasonic only), last channel recall, favorite channel memory, sleep timer, channel 2 or 3 available.

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Also: Panasonic TZ-PC 175 Series Converter w/volume. Topcases for Panasonic, SA and Jerrard (all models) also available. Call for pricing and availability.



Panasonic TZPC 145 **\$65**
channel 2 or 3; 10-lot prices

SA 8511 channel 3 8-lot: **\$65**



Quality SA-Compatible Remotes



SRC 8600A
Operates 8600 on-screen programming converters

\$6.25



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Operates 8540 & 8590 series volume-control converters

\$6.25



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SRC 075A
Operates all beige 8500 series converters

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Also available: Tocom, Hamlin, Pioneer, and Panasonic compatibles; all prices quoted in this ad are:

10-lot prices

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Operates Pioneer 8200 series converters

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JRC 450A
Operates Jerrard DRZ 450 series converters

\$5.75



JRC 550A (w/volume)
Operates DP, DPBB, DPV, DQN 5&7, Starcom VI, & DL4 series converters

\$5.75



ZRC 3 (Zenith)
Operates all Zenith PM, PZ, ST series

\$6.00

Dozens of other items in stock!

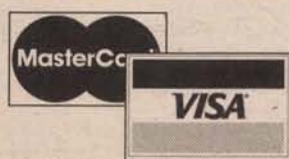
Jerrard- & SA-compatible topcases with lenses	from	\$3.25
Torx Bits & Drivers (all brands)	from	3.95
Capacitors (every voltage) at 1000-lot prices	from	.06

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TEK 7844 .400 MHz Dual Beam Oscilloscope with 7A24, 7A26, 7B80, 7B85	\$1,250.00
TEK 7854 400 MHz Waveform Processing Oscilloscope frame	\$1,250.00
TEK 7904A .500 MHz System, with 7A24, 7A26, 7B92A	\$1,250.00
TEK 7904A .500 MHz System, with 7A24, 7A26, 7B80, 7B85	\$1,250.00
TEK 7A13 105 MHz Differential Comparator	\$300.00
TEK 7A16A 225 MHz Single Trace Amplifier	\$125.00
TEK 7A19 600 MHz Single Trace Amplifier	\$175.00
TEK 7A19-opt.4 600 MHz Single Trace Amplifier, variable delay line	\$200.00

TEK 7A24 400 MHz Dual Trace Amplifier	\$350.00
TEK 7A26 200 MHz Dual Trace Amplifier	\$175.00
TEK 7A29 1 GHz Single Trace Amplifier	\$550.00
TEK 7A29-opt.04 1 GHz Single Trace Amplifier, variable delay line	\$650.00
TEK 7B15 1 GHz Delaying Time Base	\$450.00
TEK 7B80 400 MHz Delayed Time Base	\$175.00
TEK 7B85 400 MHz Delta Delaying Time Base	\$200.00

STORAGE

TEK 7834 400 MHz Storage Oscilloscope, w/7A24, 7A26, 7B80, 7B85	\$1,250.00
TEK SC503 10 MHz Dual Trace Storage Oscilloscope, TM500 series	\$700.00

SAMPLING

TEK R7903/7S11/7T11/S-4 12 GHz Sampling Oscilloscope System	\$1,750.00
TEK S-4 14 GHz Sampling Head	\$300.00

PROBES

TEK 1101 Accessory Power Supply, for FET probes	\$250.00
TEK P6046 100 MHz Differential Probe	\$750.00
TEK P6101A 34 MHz 1X Modular Probe, 2m length "NEW"	\$25.00
TEK P6108A 100 MHz 10X Modular Probe, 2m length "NEW"	\$50.00
TEK P6201 900 MHz 1X/10X/100X FET Probe	\$450.00
TEK P6202A 500 MHz 10X FET Probe	\$300.00
TEK P6203 10X 1 GHz Active Probe, for 11000 series	\$450.00
TEK P6701-opt.02 O/E Converter, 450-1050 nm/0-1 mW: DC-700 MHz, ST conn.	\$675.00

CALIBRATION

TEK 067-0587-01 Signal Standardizer Calibration Plug-in, 7000 series	\$300.00
TEK CG5001-opt.01/TM5006 Programmable Oscilloscope Calibrator, with power module	\$7,000.00
TEK CG551AP/TM506A Oscilloscope Calibrator, with pulse head & power module	\$3,500.00

WAVEFORM GENERATORS

FUNCTION

HP 3310A 5 MHz Function Generator	\$325.00
HP 3310B 5 MHz Function Generator, monocyte & var phase trigger	\$425.00
HP 3312A 13 MHz Function Generator, sweep, AM, FM	\$850.00
TEK DD501 Digital Delay & Burst Gen., for function & pulse gen's	\$375.00
TEK FG501 1 MHz Function Generator, TM500 series	\$250.00
TEK FG502 11 MHz Function Generator, TM500 series	\$325.00
TEK FG503 3 MHz Function Generator, TM500 series	\$275.00
TEK FG504 40 MHz Function Generator, TM500 series	\$875.00
TEK RG501 Ramp Generator, TM500 series	\$225.00
WAVETEK 23 12 MHz Synthesized Function Generator	\$1,100.00

PULSE

HP 214B 10 MHz Pulse Generator, 50 V/50 Ohms, auto duty cycle	\$1,650.00
HP 214B-001 10 MHz Pulse Generator, 50 V/50 ohms, counted burst opt	\$2,000.00
HP 8005B 20 MHz Dual Output Pulse Generator	\$450.00
HP 8007B 100 MHz Pulse Generator	\$650.00
HP 8013B 50 MHz Dual Output Pulse Generator, 3.5 nS fixed Tr	\$600.00
HP 8015A 50 MHz Dual Output Pulse Generator	\$700.00
HP 8080A/81A/82A/83A 300 MHz Word Generator	\$600.00
HP 8080A/91A/92A/93A 1 GHz Single Channel Pulse Generator	\$950.00
HP 8080A/91A/93A 1 GHz Clock Generator	\$600.00
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PHILIPS PM5785B 125 MHz Dual Output Pulse Gen., burst mode, 1 nS Tr	\$875.00
TEK PG501 50 MHz Pulse Generator, TM500 series	\$250.00
TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series	\$700.00
WAVETEK 801 50 MHz Pulse Generator	\$350.00

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HP 3314A Multi-Waveform Generator, 0.001 Hz-19.99 MHz, GPIB	\$3,500.00
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HP 8160A 50 MHz Programmable Pulse Generator, GPIB	\$2,500.00
HP 8165A-002,003 Prog. Signal Source, 1 mHz-50 MHz, log sweep, rear out	\$2,000.00
TEK AWG5102 Arb. Waveform Gen., 20 MS/s, 12 bits, 50ppm synthesis <1MHz	\$1,400.00
TEK AWG5105 Arbitrary Waveform Generator, 50 MS/s, 12 bits	\$1,700.00
TEK AWG5105-opt.02 Arbitrary Waveform Generator, dual channel option	\$2,200.00
TEK FG5010 Programmable 20 MHz Function Generator, TM5000 series	\$1,200.00
TEK PFG5505 Programmable 12 MHz Pulse/Function Generator	\$900.00
WAVETEK 288 20 MHz Synthesized Function Generator, GPIB	\$1,500.00

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HP 3456A 6-1/2 Digit Voltmeter	\$850.00
KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB	\$1,500.00
SOLARTRON 7081 8-1/2 digit Voltmeter	\$3,900.00
SOLARTRON 7150 5-1/2 digit Multimeter, GPIB	\$450.00

CALIBRATION

FLUKE 332B/AF DC Voltage Calibrator, 0-1111 V, 0-50 mA, 7 decades	\$675.00
FLUKE 343A DC Voltage Calibrator, 0-1100 V, 7 decades, 20 ppm acc.	\$1,375.00
FLUKE 515A Portable Calibrator, DC/AC/Ohms, line & battery power	\$1,500.00
FLUKE 5220A Transconductance Amplifier, DC-5 kHz, 0-20 A	\$3,750.00
FLUKE 720A Kelvin-Voltage Divider, 7 decade	\$2,250.00
FLUKE 731B DC Reference Standard	\$400.00
FLUKE A55-series AC Thermal Converters	\$300.00
HP 11049A AC Thermal Converter, 3 V, 20 Hz-100 MHz	\$175.00
VALHALLA 2703 AC Volt. Std., 0-120V/10 Hz-100 kHz; 120-1200V/10 Hz-1 kHz	\$2,500.00

VOLTAGE SOURCES

HP 6114A Precision Dual Range Power Supply, 20V 2 A / 40 V 1 A	\$875.00
HP 6115A Precision Dual Range Power Supply, 50V 0.8A / 100V 0.4A	\$875.00

CURRENT METERS & SOURCES

DRANETZ 656A (3)TR2019A Current Demand Analyzer, w/(3) current probes 300A max.	\$5,000.00
FLUKE Y5020 Current Shunt, to 20 A, 0.01 ohm, DC-5 kHz	\$400.00
HP 6177C DC Current Source, to 50V, 500mA	\$600.00
HP 6181C DC Current Source, to 100 V, 250 mA	\$675.00
HP 6186C DC Current Source, to 300V, 100mA	\$750.00
KEITHLEY 414A Picoammeter, 0.1 nA-10 mA	\$325.00
KEITHLEY 486 Picoammeter	\$1,500.00
KEITHLEY 614 Electrometer	\$1,000.00
KEITHLEY 642 Electrometer	\$2,900.00
LEEDS & NORTHRUP 4360 Precision Current Shunts, 15-500 Amp	\$650.00
TEK CT-5-opt.05 High Current Transformer for P6021/A6302, to 1000A	\$500.00
VALHALLA 2301 Programmable Single Phase Power Analyzer	\$1,250.00
VALHALLA 2575A AC/DC Active Current Shunt, 20 mA-100 A, DC-10 kHz	\$1,000.00

IMPEDANCE & COMPONENT TEST

L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH	\$550.00
E.S.I. 296V 4-1/2 Digit LCR Bridge, 120 Hz & 1 kHz	\$700.00
HP 4261A 3-1/2 digit LCR Meter, 120 Hz/1 kHz	\$1,000.00
HP 4262A-101 4-1/2 digit LCR Meter, 120 Hz/1 kHz/10 kHz, GPIB	\$2,200.00

STANDARDS

E.S.I. RS-925 9-Decade Resistor, 0.01 ohm-1.2 Megohm	\$1,600.00
E.S.I. SR1010 Resistance Transfer Standards, 1 ohm-100 K/step	\$700.00
E.S.I. SR1050-10M Resistance Transfer Standard, 10 Megohms/step	\$3,000.00
FLUKE 5450A Programmable Resistance Standard, 2 & 4 wire	\$1,750.00
GR 1403-SERIES Standard Air Capacitors, 0.1% accuracy	\$150.00
GR 1406 Standard Air Capacitors, GR900 connector, 0.1% acc.	\$375.00
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GR 1432-N 5-Decade Resistor, to 11,111 ohms, 0.1 ohm res.	\$175.00
GR 1432-U 4-Decade Resistor, 0-111.10 ohms, 0.01 ohm resolution	\$125.00
GR 1433-U 4-Decade Resistor, 0-111.10 ohms, 0.01 ohm resolution	\$475.00
GR 1433-X 6-Decade Resistor, to 111,111.0 ohms, 0.1 ohm res.	\$550.00

GR 1434-G 7-Decade Resistor, 0-1,111,111.0 ohms, 0.1 ohm res.	\$400.00
VALHALLA 2724A Programmable Resistance Standard, 0-11 Gigohms, GPIB	\$1,675.00

HI & LO RESISTANCE

HP 4329A High Resistance Meter, 5E5-2E16 Ohms, 10-1000 V test	\$1,350.00
VALHALLA 4150-ATC 4-1/2 digit Ohmmeter, 20 milliohms-2 kilohms, 4-wire	\$1,000.00

CURVE TRACERS

TEK 576 Curve Tracer, with standard test fixture	\$2,350.00
TEK 577D1/177 Storage Curve Tracer, with standard test fixture	\$2,250.00

T.D.R.

TEK 1502B-03,07 T.D.R., 0-2000 feet, chart recorder & battery options	\$4,750.00
TEK 1503-opt.04 Time Domain Reflectometer, 0-50,000 feet, chart recorder	\$1,900.00

POWER SUPPLIES

SINGLE OUTPUT

HP 6200B Dual Range Power Supply, 20 V 1.5 A / 40 V 0.75 A CV/CC	\$250.00
HP 6201B 20 V at 1.5A CV/CC Power Supply	\$200.00
HP 6206B Dual Range 0-60 V 0.5 A / 0-30 V 1 A CV/CL Supply	\$250.00
HP 6207B 160 V at 200 mA CV/CC Power Supply	\$300.00
HP 6209B 320 V at 100 mA CV/CC Power Supply	\$300.00
HP 6260B-027 10V at 100A CV/CC Power Supply	\$675.00
HP 6261B-027 20 V at 50 A CV/CC Power Supply	\$675.00
HP 6263B 20 V at 10 A CV/CC Power Supply	\$400.00
HP 6266B 40 V at 5 A CV/CC Power Supply	\$400.00
HP 6267B 40 V at 10 A CV/CC Power Supply	\$550.00
HP 6268B-027 40 V at 30 A CV/CC Power Supply	\$850.00
HP 6299A 100 V at 750 mA CV/CC Power Supply	\$250.00
HP 6384A 4.0-5.5 V at 8 A CV/CL Power Supply	\$175.00
HP/HARRISON 6443B 120 V at 2.5 A CV/CC Power Supply	\$400.00
LAMBDA LES-EE-03-0V 36 V at 14.5 A CV/CC Power Supply, LED metered	\$500.00
SOERENSON DCR 110-45T 110 V at 45 A CV/CC Power Supply	\$2,200.00
SOERENSON DCR 300-6B 300 V at 6 A CV/CC Power Supply, 120 VAC 30 A line	\$950.00
SOERENSON DCR 300-8A 300 V at 8 A CV/CC Power Supply, 208/230 VAC line	\$950.00
SOERENSON SRL 20-12 20 V at 12 A CV/CC Power Supply, low noise	\$550.00
SOERENSON SRL 60-80 60 V at 8 A CV/CC Power Supply, low noise	\$950.00
TEK PS501-1 Power Supply, 0-20 V, 2 mV res., 400 mA, TM500 series	\$175.00

MULTIPLE OUTPUT

HP 6227B Dual 25 V at 2 A CV/CC Power Supply, tracking	\$550.00
HP 6253A Dual Output 20 V 3 A CV/CC Power Supply	\$500.00
HP 6255A Dual Output 40 V 1.5 A CV/CC Power Supply	\$500.00
TEK PS5010 Programmable Triple Power Supply, TM5000 series	\$800.00

MISCELLANEOUS

HP 59501A GPIB Isolated DAC/Power Supply Programmer	\$175.00
HP 6824A Bipolar Power Supply/Amplifier, to 50 V, 1 A	\$400.00
HP 6827A Bipolar Power Supply/Amplifier, to 100 V, 500 mA	\$800.00
KEPCO BOP 100-4M Bipolar Supply / Amplifier, 0-100 V, 0-4 A	\$1,000.00
KIKUSUI PLZ-300W Programmable Load, 0-60 V, 0-60 A, 300 Watts max.	\$700.00
KIKUSUI PLZ-72W Programmable Load, 4-110 V, 0-12 A, 70 Watts max.	\$225.00
TRANSISTOR DEVICES DAL-50-15-100 Programmable Load, 0-50 V, 0-15 A, 100 Watts max.	\$200.00

TIME & FREQUENCY

UNIVERSAL COUNTERS

HP 5315A-001 100 MHz/100 nS Universal Counter, TCXO reference	\$650.00
HP 5315A-001,003 100 MHz/100 nS Universal Counter, TCXO, 1 GHz C-channel	\$800.00
HP 5316A 100 MHz/100 nS Universal Counter, GPIB	\$750.00
HP 5316A-003,006 100 MHz/100 nS Counter, 1 GHz C-ch., offset/normalize	\$1,100.00
HP 5334A 100 MHz Universal Counter, GPIB	\$875.00
HP 5335A 200 MHz Universal / Statistical Counter	\$1,500.00
HP E1420A-010,030 VXI card 200 MHz/ 2 nS Univ. Counter, TCXO & 2.5 GHz C-ch	\$900.00
PHILIPS PM6654/056 120 MHz/ 2 nS Programmable High Res. Counter, OCXO, GPIB	\$850.00
RACAL-DANA 1992-04,55 100 MHz/1 nS Univ. Counter, 1.3 GHz C-channel, OCXO, GPIB	\$850.00
TEK DC5004 Programmable 100 MHz/100nS Counter/Timer, TM5000 series	\$350.00
TEK DC5009 Programmable 135 MHz Univ. Counter/Timer, TM5000 series	\$600.00
TEK DC5010 350 MHz/3.125 nS Univ. Counter, TM5000 series	\$1,000.00
TEK DC503A 125 MHz Universal Counter/Timer, TM500 series	\$450.00

FREQUENCY COUNTERS

EIP 575 18 GHz Source Locking Counter, GPIB	\$3,250.00
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90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS



FLUKE 7220A-opt.111 1.3 GHz Communications Counter, TCXO option	\$650.00
HP 5340A-001,011 18 GHz Frequency Counter, OCXO reference, HPIB	\$1,900.00
HP 5340A-005,011 23 GHz Frequency Counter, HPIB	\$2,000.00
HP 5342A 18 GHz Frequency Counter	\$2,400.00
HP 5342A-003,011 18 GHz Freq. Counter, +22 dBm, -20 dBm dynamic range, HPIB	\$2,750.00
HP 5342A-01,04,05,11 24 GHz Frequency Counter, OCXO, DAC, and HPIB	\$3,900.00
HP 5345A/5355A/5356B 26.5 GHz CW/Pulse Frequency Counter	\$4,000.00
HP 5382A 225 MHz Frequency Counter	\$200.00
MISCELLANEOUS	
HP 105A Quartz Oscillator, 0.1/1.0/5.0 MHz	\$750.00
HP 5087A-031 Distribution Amp., 0.1/1.0/5.0 MHz x 4 channels each	\$1,250.00

AUDIO & BASEBAND

SPECTRUM ANALYZERS

HP 8556A LF Section, 20 Hz-300 kHz	\$500.00
TEK 7L5-opt.025/L3-1 Spectrum Analyzer, 20 Hz-5 MHz, 75 / 600 / 1M ohms	\$2,250.00

DISTORTION ANALYZERS

HP 334A Distortion Analyzer, 5 Hz-600 kHz, -60 dB, auto nulling	\$550.00
HP 339A Distortion Analyzer, built-in low distortion osc.	\$2,400.00
TEK DA4084 Programmable Distortion Analyzer, 0.0025% THD, w/frame	\$1,500.00

RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, 180 uV-700 V, 10 Hz-20 MHz	\$700.00
FLUKE 8921A True RMS Voltmeter, 180 uV-700 V, 2 Hz-2 MHz	\$700.00

OSCILLATORS

FLUKE 6011A Synthesized Generator, 10 Hz-11 MHz, 10 Hz res.	\$1,200.00
HP 204D Oscillator, 5 Hz-1.2 MHz, 5 VRMS, 80 dB step attenuator	\$200.00
HP 209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5 VRMS max.	\$225.00
HP 239A Low Distortion Oscillator, 10 Hz-100 kHz	\$450.00
HP 652A Test Oscillator, 10 Hz-10 MHz	\$300.00
ROCKLAND 5100 Synthesizer, 1 mHz-1.999999999 MHz	\$350.00
TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten., TM500	\$350.00
TEK SG505-opt.01 Low Distortion Oscillator, 10 Hz-100 kHz, intermod. opt.	\$1,000.00

MISCELLANEOUS

HP 3575A-001 Phase-Gain Meter, 1 Hz-13 MHz, dual display	\$900.00
HP 4437A Step Attenuator, 0-119.9 dB, DC-1 MHz, 600 ohms unbal.	\$200.00
KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave	\$500.00
KROHN-HITE 3202 Dual High-Pass/Low-Pass Filter, 20 Hz-2 MHz, 24 dB/oct	\$600.00
KROHN-HITE 3342 Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave	\$1,100.00
KROHN-HITE 3750 LP/HP/BP/BR Filter, 0.02 Hz-20 kHz, 6/12/18/24 dB/oct.	\$700.00
ROCKLAND 852 Dual Highpass/Lowpass Filter, 0.1 Hz-111 kHz	\$1,000.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series	\$575.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11517A/18A/19A/20A Mixer, 12.4-40 GHz, w/adapters, for 8555A, 8565A, etc.	\$675.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz	\$1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz	\$1,400.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz	\$1,400.00
HP 11971A WR28 Harmonic Mixer, 26.5-40.0 GHz, for 8569B	\$1,100.00
HP 11971K WR42 Harmonic Mixer, 18.0-26.5 GHz, for 8569B	\$1,100.00
HP 8406A Comb Generator, 1/10/100 MHz increments, to 5 GHz	\$450.00
HP 8444A-059 Tracking Generator, 0.5-1500 MHz, for 8554, 8568, etc.	\$1,500.00
HP 8445B Preselector, 1.8-18.0 GHz, for HP 8555A	\$800.00
HP 8559A/853A Spectrum Analyzer, 10 MHz-21 GHz, 1 kHz res., w/display	\$5,500.00
TEK 7L13/7613 Spectrum Analyzer, 1 kHz-1.8 GHz, 30 Hz min. res., w/frame	\$2,250.00
TEK TR502 Tracking Generator, 0.1-1800 MHz, for 7L12/13/14	\$1,250.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492/4/5/6	\$1,375.00

NETWORK ANALYZERS

HP 11589A Bias Network, 0.1-3.0 GHz, N(f/f)	\$350.00
HP 11590A Bias Network, 1.0-12.4 GHz, N(f/f)	\$375.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7	\$450.00
HP 11665B Modulator, 0.15-18.0 GHz, for use with 8755/6/7	\$375.00
HP 11666A Reflectometer Bridge, 0.04-18 GHz, for 8755/8/756	\$1,200.00
HP 8407A/8412A/8601A Network Analyzer, 100 kHz-110 MHz, with sweep generator	\$1,250.00
HP 85050D APC7 Calibration Kit, for 8510 series	\$1,100.00
HP 8505A-005/8503A Network An., 0.5-1300 MHz, w/S-Parameter & phase lock	\$5,000.00
HP 8755C(3)/11664A/182T Scalar Network An. w/3 detectors, 10 MHz-18 GHz & frame	\$1,750.00
HP 8756A(3)/11664A Scalar Network Analyzer, w/(3) detectors, 0.01-18 GHz	\$3,750.00
NARDA 7000A/7202/7206 Microwave Multimeter System: scalar analysis 0.1-18 GHz	\$1,950.00
WAVETEK 1038D/14A/H12/V13x2 Scalar Network An. w/(3)15882 WR28 detectors, 26.5-40 GHz	\$2,200.00
WILTRON 640/G50/E(2)/7B50(2) Network An., w/1-1500 MHz source, (2) log amp, (2) det.	\$1,675.00

SIGNAL GENERATORS

FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res., GPIB	\$2,000.00
GIGATRONICS 600/10-18, opt.06 Synthesized Source, 10-18 GHz, 1 MHz res., OCXO, GPIB	\$3,000.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm	\$3,500.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs	\$7,000.00
GIGATRONICS 910/12-18, opt.6, 14, 16 Synthesized Source/Sweeper, 12-18 GHz, 1 Hz res., OCXO	\$3,500.00
HP 85100V Frequency Mull., 10-15 GHz in / 50-75 GHz out >0 dBm	\$4,250.00
HP 8616A Signal Generator, 1.8-4.5 GHz	\$450.00
HP 8640B-001,002,003 Signal Gen., 0.5-1024 MHz, AM, FM, var. audio osc.	\$2,750.00
HP 8647A-1E5 Synth. Signal Gen., 0.25-1000 MHz, display res. 10 Hz	\$3,750.00
HP 8654A Signal Generator, 10-520 MHz, calibrated AM & uncal. FM	\$625.00
HP 8656A Signal Generator, 0.1-990 MHz, 100 Hz res., AM, FM, HPIB	\$2,900.00
HP 8660C/86602B/86632A Synthesized Signal Gen., 1-1300 MHz, 1 Hz res., AM, FM	\$2,750.00
HP 8660D/86603A/86632B Synthesized Signal Generator, 1-2600 MHz	\$7,000.00
WAVETEK 907 Signal Generator, 7.0-11.0 GHz, 0 dBm levelled	\$1,000.00

SWEEP GENERATORS

HP 8350A/86290B-H08 Programmable Sweep System, 2.0-22.0 GHz, +4 dBm lvd	\$5,500.00
HP 8600A Digital Marker, for HP 8601A	\$400.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled	\$500.00
HP 8620C Sweep Oscillator Frame	\$550.00
HP 8620C-011 Sweep Oscillator Frame, HPIB programmable	\$675.00
HP 86222B-002 RF Plug-in, 1 0-2400 MHz, +10 dBm levelled, step atten.	\$1,750.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled	\$675.00
HP 86240A RF Plug-in, 2.0-8.4 GHz, +16 dBm levelled	\$1,000.00
HP 86240A-002 RF Plug-in, 2.0-8.4 GHz, +14 dBm lvd, 70 dB step att.	\$1,200.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled	\$500.00
HP 86242D-004,008 RF Plug-in, 5.9-9.0 GHz, +10 dBm levelled	\$500.00
HP 86245A RF Plug-in, 5.9-12.4 GHz, +16 dBm levelled	\$1,100.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled	\$675.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled	\$800.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled	\$800.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled	\$1,750.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled	\$2,500.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld.	\$2,000.00

POWER METERS

ANRITSU MP-81B/ML-83A Power Meter, 75-110 GHz (WR10), -20 to +20 dBm	\$2,500.00
ANRITSU MP-82B/ML-83A Power Meter, 90-140 GHz (WR8), -20 to +20 dBm	\$3,250.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor	\$500.00
BOONTON 42B/42A-S3 Analog Power Meter, with 1 MHz-8.4 GHz N(f) sensor	\$375.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm	\$375.00
HP 432A/478A Power Meter, 10 MHz-18 GHz, -20 to +10 dBm f.s.	\$375.00
HP 432A/8478B Power Meter, 10 MHz-18 GHz, -20 to +10 dBm f.s.	\$500.00
HP 432C Autoranging Digital Power Meter, 10 uW-10 mW f.s.	\$425.00
HP 435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm	\$1,000.00
HP 435A/8481H Power Meter, 10 MHz-18 GHz, -15 to +35 dBm	\$1,150.00
HP 435A/8482A Power Meter, 100 kHz-4.2 GHz, -30 to +20 dBm	\$1,000.00
HP 435A/8482H Power Meter, 0.1-4200 MHz, -15 to +34 dBm	\$1,150.00
HP 435A/8483A Power Meter, 0.1-2000 MHz, -30 to +20 dBm, 75 ohms	\$1,000.00
HP 436A-022 Digital Power Meter, HPIB option	\$1,400.00
HP K486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series	\$350.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8	\$1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40.0 GHz, for 432 series	\$350.00

RF MILLIVOLTMETERS

RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB	\$875.00
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AMPLIFIERS, MISCELLANEOUS

ALITECH 7618E Noise Source, 10 MHz-18 GHz, SMA(m), 15 dB ENR	\$500.00
BOONTON 82AD FM/AM Modulation Meter, 10-1200 MHz	\$800.00
HP 8447A-001 Dual Amplifier, 0.1-400 MHz	\$500.00
HP 8901A-002,010 Modulation Analyzer, 150 kHz-1300 MHz, OCXO, int. cal.	\$5,500.00
M.P.D. LAB2-1020-2A Amplifier, 34 dB, 1.0-2.0 GHz, 2 Watts	\$800.00
M.P.D. LAB2-714-3A Amplifier, 34 dB, 0.7-1.4 GHz, 3 Watts	\$800.00
MARCONI TF2304 AM/FM Modulation Meter, 18-1000 MHz, FM dev. 1.5-150 kHz	\$500.00
MICROWAVE SEMI-CORP. MC5112 Noise Source, 25.5 dB ENR, 1.0-12.4 GHz, N(m), +28 VDC	\$325.00

COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna, LHC, 2-18 GHz, TNC(f) "NEW"	\$95.00
CONTINENTAL MW.&TOOL PLPT42 WR42 Low Power Termination, 18-26.5 GHz, 1 Watt	\$125.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f)	\$90.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz	\$450.00
GR 900-Q GR900 14mm Interseries Adapters	\$125.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz	\$450.00

HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz	\$800.00
HP 775D Dual Directional Coupler, 20 dB, 450-940 MHz	\$275.00
HP 776D Dual Directional Coupler, 20 dB, 940-1900 MHz	\$275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz	\$275.00
HP 778D Dual Dir. Coupler, 20 dB, 100-2000 MHz, N(m/f/f/f)	\$550.00
HP 778D-011 Dual Dir. Coupler, 20 dB, 100-2000 MHz, APC7/N(f/f/f)	\$400.00
HP 8470B-012 Crystal Detector, 10 MHz-18 GHz, neg. pol., N(m)	\$250.00
HP 8498A-030 30 dB Attenuator, 25 Watts, DC-18 GHz, N(m/f)	\$600.00
HP K382A WR42 Precision Rotary Vane Atten., 0-50 dB, 18-26.5 GHz	\$2,750.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz	\$350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz	\$500.00
HP K752 A/C/D WR42 Directional Couplers, 3/10/20 dB, 18.0-26.5 GHz	\$450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz	\$275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz	\$425.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz	\$650.00
HP R375A WR28 Variable Attenuator, 0-20 dB, 26.5-40 GHz	\$375.00
HP R422A WR28 Flat Broadband Detector, 26.5-40 GHz	\$400.00
HP R532A WR28 Frequency Meter, 26.5-40.0 GHz	\$500.00
HP R914B WR28 Moving Load, 26.5-40 GHz	\$300.00
HP X913A WR90 High Power Load, 500 Watts, 8.2-12.4 GHz	\$1,500.00
HUGHES 4511H-2000 WR28 Isolator, 25 dB, 26.5-40 GHz	\$450.00
HUGHES 4511H-1000 WR19 Isolator, 25 dB, 40-60 GHz	\$650.00
HUGHES 4551H-1001 WR15 Stepper Motor Driven 4-Port Switch, with driver	\$1,675.00
HUGHES 4552H-2000 WR28 Manual 4-Position Switch	\$750.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity	\$750.00
HUGHES 47974H-1000 WR15 SPST PIN Switch, 250 MHz speed, 60-62 GHz response	\$375.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz	\$450.00
NARDA 25171 Level Set Attenuator, 0-17 dB, 2-8 GHz, SMA(f)	\$100.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f/f)	\$200.00
NARDA 3000-SERIES Directional Couplers	\$150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz	\$300.00
NARDA 3090-SERIES Precision High Directivity Couplers	\$225.00
NARDA 369BNF High Power Termination, 175 Watts, 0.7-18 GHz, N(f)	\$325.00
NARDA 3753B Coaxial Phase Shifter, 0-60 deg./GHz, 3.5-12.4 GHz	\$1,250.00
NARDA 4000-SERIES SMA Miniature Directional Couplers	\$75.00
NARDA 4203-6 Directional Coupler, 6 dB, 2-18 GHz, SMA(f/f/f)	\$225.00
NARDA 4246B-20 Directional Coupler, 20 dB, 6-18 GHz, SMA(f)	\$100.00
NARDA 4317-2 Power Divider, 18.0-26.5 GHz, 3.5mm	\$175.00
NARDA 4799 Level Set Attenuator, 0-15 dB, 4-18 GHz, SMA(f)	\$135.00
NARDA 5070-SERIES Precision Reflectometer Couplers	\$300.00
NARDA 765-20 20 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f)	\$135.00
NARDA 768-20 20 dB Attenuator, 20 Watts, DC-11 GHz, N(m/f)	\$125.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz	\$375.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz	\$250.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz	\$125.00
SPACEK LABS DQ-1 WR22 Flat Broadband Detector, 33-50 GHz	\$550.00
TELONIC TTF-2250-5-SEE Tuneable Bandpass Filter, 1.5-3.0 GHz, 5% 3 dB BW, N(f)	\$350.00
TRG V510 WR15 Precision Rotary Vane Atten., 0-50 dB, 50-75 GHz	\$1,000.00
TRG V551 WR15 Frequency Meter, 50-75 GHz	\$600.00
TRG V559-10 WR15 Directional Coupler, 10 dB, 50-75 GHz	\$400.00
TRG W510 WR10 Precision Rotary Vane Atten., 0-50 dB, 75-110 GHz	\$1,000.00
TRG W551 WR10 Frequency Meter, 75-110 GHz	\$900.00
TRG W559-10 WR10 Directional Coupler, 10 dB, 75-110 GHz	\$475.00
WAVELINE 822 WR42 Precision Rotary Vane Atten., 0-50 dB, 18-26.5 GHz	\$1,250.00
WAVELINE 898-DR WR42 Frequency Meter, 18.0-26.5 GHz	\$350.00
WEINSCHEL 49-6-34 6 dB Attenuator, 150 Watts, DC-8 GHz, N(f/m)	\$250.00
WILTRON 26N50 Precision Termination, N(m), DC-18 GHz	\$250.00
WILTRON 87A50 VSWR Bridge, 2-18 GHz, 35 dB dir., APC7 test port	\$750.00

LOGIC

HP 5005A Signature Multimeter	\$350.00
HP 8170A-002 Logic Pattern Generator, 2 MB/s, address driver option	\$1,200.00
TEK 1240 Logic Analyzer, w/(36) 50 MHz channels	\$1,500.00

COMMUNICATIONS

HP 4972A/18182A LAN Protocol Analyzer, with software	\$2,500.00
HP 59401A HPIB Bus Analyzer	\$700.00
TEK 1411R-opt.04 PAL Test Gen. w/SPG12, TSG11, TSP11, TSG13, TSG15, TSG16	\$2,750.00
TEK 147A NTSC Test Signal Generator, with noise test signal	\$800.00
TEK 520A NTSC Vectorscope	\$1,200.00

MISCELLANEOUS

P.A.R. 5205-94, 95, 96 Lock-In Amp., 20 Hz-20 kHz, int. osc., lin/log, GPIB	\$2,750.00
P.A.R. 5206 Two-Phase Lock-In Amplifier, 2 Hz-200 kHz	\$2,500.00
P.A.R. 5208-92, 94, 97, 98 Two Phase Lock-In Amp., 5 Hz-20 kHz or 200 kHz, GPIB	\$3,250.00
TEK TM5006 5000-series 6-slot Programmable Power Module	\$600.00
TEK TM503 500-series 3-slot Power Module	\$175.00
TEK TM504 500-series 4-slot Power Module	\$175.00
TEK TM506 500-series 6-slot Power Module	\$250.00
TEK TM515 500-series 5-slot Traveller Power Module	\$275.00

Events

CALENDAR

DECEMBER 1996

DECEMBER 1

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857

CO - DENVER - Computer Show & Swap Meet. Jefferson Co. Fairgrounds. Greg 303-444-2664

DE - NEWARK - Computer Show. University of Delaware. MarketPro 301-984-0880 xt15

FL - PALM BEACH GARDENS - Computer Show. Marriott. 4000 RCA Blvd. Narisam 770-663-0983

KY - ERLANGER - Computer Show. Holiday Inn, Cincinnati Airport. Higgins Archer Show Promotions 1-800-672-3472

ME - AUGUSTA - Computer Show. Augusta Civic Center. 10am-3:30pm. Northern Computer 508-744-8440

MI - FLINT - Computer Show. Holiday Inn, Gateway Centre. US-23 @ Hill Rd. Exit. Five Star Productions. 810-230-0988

MI - HAZEL PARK - Hamfest. Hazel Park High School. 23400 Hughes St. HPARC Inc. Swap, POB 368, Hazel Park, MI 48030. 8am-2pm

MI - LANSING - Super Computer Sales. Holiday Inn S. Conv. Center. 6820 S. Cedar St. 10am-4pm. Computers & You 313-283-1754

NJ - FAIRFIELD - Computer Show. Fairfield Radisson. 9:30am-4pm. MarketPro 201-825-2229

OH - DAYTON - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880 xt15

VA - CHANTILLY - Computer Show. Capital Expo Center. MarketPro 301-984-0880 xt15

DECEMBER 6-7

AR - HOT SPRINGS - Arkansas DX Convention. Dave Jacques 501-760-1181

DECEMBER 7

AL - DOTHAN - Hamfest. Wiregrass ARC. Joe Higginbotham 334-677-5439

AZ - MESA - Hamfest. Superstition ARC. 7am-3pm. SE corner of Dobson & Southern I-60 Dobson Rd. exit. Chuck Kruppenbacher 602-986-3060

CA - SAN FRANCISCO - Computer Show. Cow Palace. Robert Austin. 1-800-346-0100

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

FL - OKEECHOBEE - Hamfest. Okeechobee ARC. Al Berryman 941-467-0516

IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond corner Sherman exit 109 at I-65. 317-299-8827

IN - FT. WAYNE - Computer Show. Allen County Fairgrounds. MarketPro 301-984-0880 xt15

LA - MINDEN - ARRL Hamfest. Minden ARA. Jimmy White 318-377-2501

MA - WEST SPRINGFIELD - Computer Show. Eastern States Expo. 9:30am-4pm. MarketPro 201-825-2229

MI - SOUTHFIELD - Super Computer Sales. Southfield Pavilion. 26000 Evergreen. 10am-3pm. Computers & You 313-283-1754

MN - GOLDEN VALLEY - Handi-Ham Winter Hamfest. Courage Center. 3915 Golden Valley Rd. Don Franz W0FIT 507-373-4745

NC - GREENSBORO - Hamfest & Computer Show. GGH 910-852-9244. 9am-3pm

NH - SEABROOK - Computer Show. Greyhound Park. 10am-3:30pm. Northern Computer Shows 508-744-8440

DECEMBER 7-8

GA - ATLANTA - Computer Show & Internet Seminars. N. Atlanta Trade Center 912-424-0808

MD - NEW CARROLLTON - Computer Show. Ramada Conf. & Exhibition Ctr 301-984-0880 xt15

DECEMBER 8

MA - HYANNIS - Computer Show. Tara Cape Codder Hotel. 10am-3:30pm. Northern Computer Shows 508-744-8440

MI - GRAND RAPIDS - Super Computer Sales. Crowne Plaza. 5700 28th St. S.E. 10am-4pm. Computers & You 313-283-1754

OH - TOLEDO - Computer Show. SeaGate Convention Centre. MarketPro 301-984-0880 xt15

NY - Poughkeepsie - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229

WI - GREEN BAY - Swapfest. Ashwaubenon High School. 2391 S. Ridge Rd. 8am-1pm. Scott Cole 414-496-0989

DECEMBER 8-9-10-11

NV - LAS VEGAS - Hamfest. Western USA & Mexico Chaverim Chapter. Irv Mirovich 818-986-9438

DECEMBER 13-14-15

MN - ST. CLOUD - Computer Sale/Show. Civic Center. Blue Star Productions. 612-788-1901

The Events Calendar is a free service limited to electronic events such as computer shows, hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days prior to the event. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

DECEMBER 14

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

FL - LAKE CITY - Hamfest. Florida National Guard Armory. 153rd Engr. Co. Lake Jeffery Rd. 904-755-7969

IL - JACKSONVILLE - Superfest. Jacksonville ARS 664 S. Lincoln Ave. 8am-2pm. c/o Kaye Green KB9KHQ, 27 Ivy Wood Dr., Jacksonville, IL 62650

MI - KALAMAZOO - Super Computer Sales. Kalamazoo Co. Fairground. 2900 Lake St. 10am-3pm. Computers & You 313-283-1754

NY - STONY BROOK - Computer Show. SUNY Stony Brook. 9:30am-4pm. MarketPro 201-825-2229

SC - UNION - Hamfest. National Guard Armory. Industrial Park Rd. 8am-3pm. Roger W. Gregory 864-427-1462

VA - HAMPTON - Computer Show. Hampton Coliseum. MarketPro 301-984-0880 xt15

DECEMBER 14-15

FL - FT. LAUDERDALE - Computer Show. War Memorial Auditorium. MarketPro 301-984-0880 xt15

GA - PERRY - Computer Show. Georgia National Fairgrounds & Agricenter. 401 Larry Walker Pkwy. Sat. 9am-5pm, Sun. 10am-4pm. 770-907-6225

IL - CHICAGO - Computer Show. Higgins Archer Show Promotions 1-800-672-3472

KY - LOUISVILLE - Computer Show. Commonwealth Conv. Center. MarketPro 301-984-0880 xt15

PA - HARRISBURG - Computer Show. Harrisburg Farm Show Complex. MarketPro 301-984-0880 xt15

VA - CHANTILLY - Computer Show. Capital Expo Center. MarketPro 301-984-0880 xt15

DECEMBER 15

IL - ORLAND PARK - Orland Park Computer Show. Civic Center. 147th St. & LaGrange Rd. (Rt. 45) 9:30am-3pm. 24-Hour Hotline 708-974-3123

MI - MADISON HEIGHTS - Super Computer Sales. U.F. & C.W. Hall. 876 Horace Brown Dr. 10am-4pm. Computers & You 313-283-1754

NH - SALEM - Computer Show. Rockingham Park Race Track. 10am-3:30pm. Northern Computer Shows 508-744-8440

NJ - SECAUCUS - Computer Show. Meadowlands Expo. Center. 9:30am-4pm. MarketPro 201-825-2229

VA - RICHMOND - Computer Show. The Showplace. MarketPro 301-984-0880 xt15

DECEMBER 21

CA - OAKLAND - Computer Show. Convention Center. Robert Austin 1-800-346-0100

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

MA - ROCKLAND - Computer Show. Sons of Italy Hall. 10am-3:30pm. Northern Computer Shows 508-744-8440

MI - LIVONIA - Super Computer Sales. Livonia Elks Lodge Hall. 31117 Plymouth Rd. 10am-3pm. Computers & You 313-283-1754

NH - NASHUA - Computer Show. Rivier College. 9:30am-4pm. MarketPro 201-825-2229

VA - ANNANDALE - Computer Show. Northern VA Comm. College. MarketPro 301-984-0880 xt15

VA - BRISTOL - Computer Show. Viking Hall. MarketPro 301-984-0880 xt15

VA - VIRGINIA BEACH - Computer Show. Independence Hall. 4816 Columbus St. Pro Am Computer Shows 757-481-2826

DECEMBER 21-22

FL - ORLANDO - Computer Show. Central Florida Fairgrounds. MarketPro 301-984-0880 xt15

GA - ATLANTA - Computer Show. Farmers Market. Alan Westberry 770-297-9256

GA - KENNESAW - Computerfest. GA Mountain Productions. 770-424-8808 706-838-4827

PA - ALLENTOWN - Computer Show. Allentown Fairgrounds. MarketPro 301-984-0880 xt15

PA - PITTSBURGH - Computer Show. Pittsburgh Expo Mart. MarketPro 301-984-0880 xt15

DECEMBER 22

CT - FARMINGTON - Computer Show. Farmington Marriott. 9:30am-4pm. MarketPro 201-825-2229

MA - TAUNTON - Computer Show. Holiday Inn. 10am-3:30pm. Northern Computer Shows 508-744-8440

MD - UPPER MARLBORO - Computer Show. The Show Place Arena. MarketPro 301-984-0880 xt15

MI - DEARBORN - Super Computer Sales. Dearborn Civic Center. 15801 Michigan Ave. Computers & You 313-283-1754

MI - FLINT - Computer Show. Holiday Inn, Gateway Centre. US-23 @ Hill Rd. Exit. Five Star Productions. 810-230-0988

VA - ROANOKE - Computer Show. Roanoke Civic Center. MarketPro 301-984-0880 xt15

VA - VIRGINIA BEACH - Computer Show. VA Beach Pavilion. 1000 19th St. Pro Am Computer Shows 757-481-2826

DECEMBER 23

NH - MANCHESTER - Computer Show. Center of NH Complex. 10am-3:30pm. Northern Computer Shows 508-744-8440

DECEMBER 28

CA - SAN FRANCISCO - Robert Austin Computer Show. Cow Palace. 1-800-346-0100

MD - BALTIMORE - Computer Show. Martin's Eastwind. MarketPro 301-984-0880 xt15

MI - TAYLOR - Super Computer Sales. Democratic Club Hall. 23400 Wick Rd. 10am-3pm. Computers & You 313-283-1754

OH - DAYTON - Computer Show. Montgomery County Fairgrounds. MarketPro 301-984-0880 xt15

DECEMBER 28-29

FL - MELBOURNE - Computer Show. Melbourne Civic Auditorium. MarketPro 301-984-0880 xt15

NJ - PARSIPPANY - Computer Show. ParsIPPany Hilton. 9:30am-4pm. MarketPro 201-825-2229

MD - GAITHERSBURG - Computer Show. Montgomery Co. Fgnds. MarketPro 301-984-0880 xt15

PA - KING OF PRUSSIA - Computer Show. Valley Forge Conv. Center. MarketPro 301-984-0880 xt15

VA - VIRGINIA BEACH - Computer Show. Independence Hall. 4816 Columbus St. Pro Am Computer Shows 757-481-2826

DECEMBER 29

MD - TIMONIU - Computer Show. Maryland State Fairgrounds. MarketPro 301-984-0880 xt15

MI - MADISON HEIGHTS - Super Computer Sales. U.F. & C.W. Hall. 876 Horace Brown Dr. 10am-4pm. Computers & You 313-283-1754

OH - COLUMBUS - Computer Show. Ohio Expositions Center. MarketPro 301-984-0880 xt15

JANUARY 1997

JANUARY 4

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

MD - BALTIMORE - Computer Show. Martins West. MarketPro 301-984-0880 xt15

NH - PORTSMOUTH - Computer Show. Frank Jones Center. 10am-3:30pm. Northern Computer Shows 508-744-8440

PA - PHILADELPHIA - Computer Show. Adams Mark. MarketPro 301-984-0880 xt15

TN - MORRISTOWN - Hamfest. Lakeway ARC. Perry Hensley 423-828-4848

JANUARY 4-5

FL - CAPE CORAL - Hamfest. Ft. Myers ARC. Jackie Kampfert 941-542-6675

FL - TAMPA - Computer Show. FL State Fgnds. MarketPro 301-984-0880 xt15

PA - MONROEVILLE - Computer Show. Pittsburgh Expo Mart. MarketPro 301-984-0880 xt15

VA - CHANTILLY - Computer Show. Capital Expo Center. MarketPro 301-984-0880 xt15

VA - HAMPTON - Computer Show. Hampton Coliseum. MarketPro 301-984-0880 xt15

JANUARY 5

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857

IN - SOUTH BEND - Hamfest. Michiana Valley Hamfest Assn. Bob Denniston 219-291-0252

MD - TOWSON - Computer Show. Towson State University. MarketPro 301-984-0880 xt15

NJ - CHERRY HILL - Computer Show. Hilton at Cherry Hill. MarketPro 301-984-0880 xt15

PA - DICKSON CITY - Computer Show. Genetti Manor. MarketPro 301-984-0880 xt15

PA - MONROEVILLE - Computer Show. Pittsburgh Expo Mart. MarketPro 301-984-0880 xt15

JANUARY 11

AZ - GLENDALE - Hamfest. Glendale Community College N. Lot. 6000 W. Olive. 6am-1pm. Mark KC7BXS 602-931-1204

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

CO - LOVELAND - Superfest. Larimer County Fgnds. 700 Railroad Ave. 9am-3pm. 970-352-5304

NY - MARATHON - Hamfest. Skyline ARC. 607-849-6751

TX - SAN ANTONIO - Hamfest. San Antonio RC. Eric Smith 210-684-2513

VA - ANNANDALE - Computer Show. N. Virginia Community College. MarketPro 301-984-0880 xt15

JANUARY 11-12

FL - JACKSONVILLE - Computer Show. Jacksonville Fairgrounds. MarketPro 301-984-0880 xt15

FL - SARASOTA - Hamfest. Sarasota ARA. Fred Auerbach 941-365-7679

GA - NORCROSS - Computer Show. North Atlantic Trade Center. MarketPro 301-984-0880 xt15

KY - LOUISVILLE - Computer Show. Commonwealth Convention Ctr. MarketPro 301-984-0880 xt15

OH - BERE - Computer Show. Cuyahoga County Fairgrounds. MarketPro 301-984-0880 xt15

PA - ALLENTOWN - Computer Show. Allentown Fairgrounds. MarketPro 301-984-0880 xt15

JANUARY 12

MD - NEW CARROLLTON - Computer Show. Ramada Conf. & Exhibition Ctr. MarketPro 301-984-0880 xt15

WI - WADKESHA - Hamfest. West Allis RAC. Phil Gural 414-425-3649

JANUARY 18

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

FL - CRYSTAL RIVER - Hamfest. Sky High ARC. 352-746-1299

MD - FREDERICK - Computer Show. Frederick Fairgrounds. MarketPro 301-984-0880 xt15

MI - FLINT - Hamfest. Southwestern Academy. 8am-2pm. Keith Allen N8QNA 810-232-5170

MO - ST. JOSEPH - Hamfest. Ramada Inn. Missouri Valley ARC. I-29 & Frederick Ave. 9am-4pm. 816-424-6484

NH - NASHUA - Electronic Fleamart. 617-923-2665

NH - SALEM - Computer Show. Rockingham Park Race Track. 10am-3:30pm. Northern Computer Shows 508-744-8440

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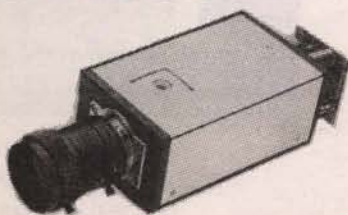
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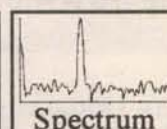
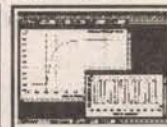
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S032	32	.14	.13	.12
S040	40	.14	.13	.12

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P012K	2K Ω	.69	.66	.59
P015K	5K Ω	.69	.66	.59
P0110K	10K Ω	.69	.66	.59
P0120K	20K Ω	.69	.66	.59
P0150K	50K Ω	.69	.66	.59
P01100K	100K Ω	.69	.66	.59
P01200K	200K Ω	.69	.66	.59
P01500K	500K Ω	.69	.66	.59
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STOCK#	VALUE	1-24	25-99	100+
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P01100	100 Ω	.69	.66	.59
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P012K	2K Ω	.69	.66	.59
P015K	5K Ω	.69	.66	.59
P0110K	10K Ω	.69	.66	.59
P0120K	20K Ω	.69	.66	.59
P0150K	50K Ω	.69	.66	.59
P01100K	100K Ω	.69	.66	.59
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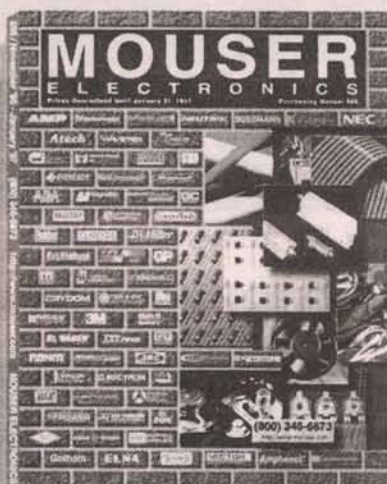
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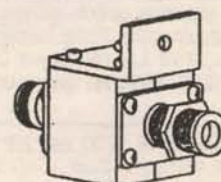
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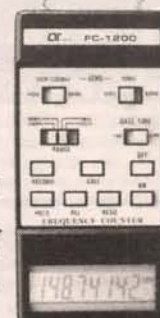
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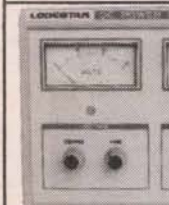
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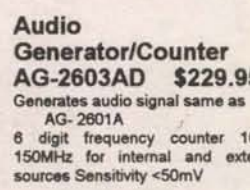


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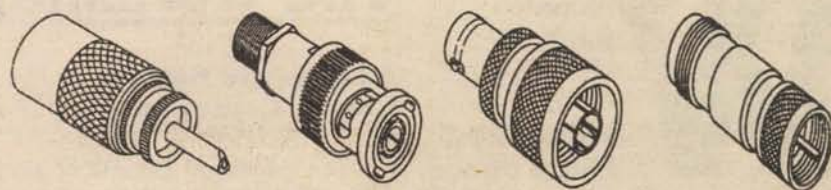
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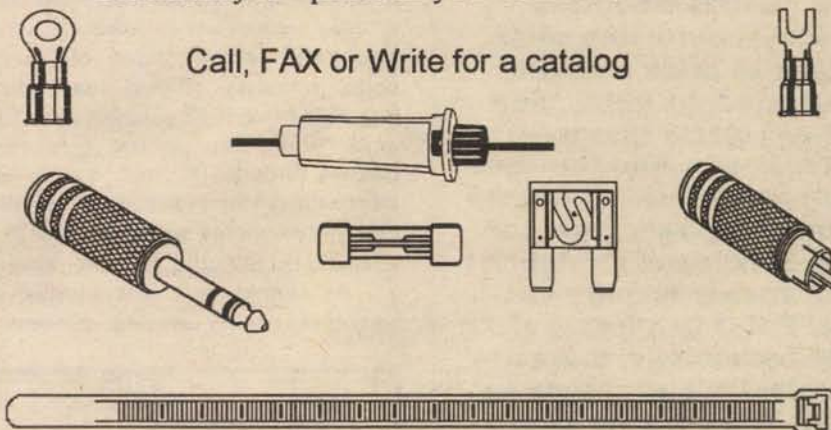
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THE NUTS & VOLTS SOLAR WORKSHOP

Welcome to The N&V Solar Workshop ...

How To Use The Sun After Sundown

Welcome back to the N&V Solar Workshop. Since our last meeting, I've received requests from more than a few readers who have asked about using solar power to drive satellite dishes, night lights, and other objects that work after hours. And the question always is, "How can I store the power from the day to be used at night?" The answer is quite simple: Put it in a battery! The technology, unfortunately, isn't as simple as that. There's a lot more to keeping a battery alive than just slapping a voltage or lightning bolt across its electrodes (the Monster, he lives!).

My problem is that talking about batteries and how they have to be treated is a topic that takes a lot more magazine pages than I have room for in a single issue, and it takes precious time away from our study of photovoltaics. So bear with me as I integrate the two over the next couple of months.

In today's workshop, I'll show you how to construct a charge controller for lead-acid batteries, the mainstay of large-scale photovoltaics. I was hoping to include information about NiCad (nickel-cadmium) and other rechargeable batteries, too. But when I sat down to play the lead-acid piano it turned into a cathedral-size pipe organ — so NiCad will have to wait until next month. Today's classroom shows you how to match the battery size and capacity with the output of your solar panels.

The Workshop

A Lead-Acid Battery Charge Controller

The traditional method of storing solar electricity is inside a lead-acid battery. A lead-acid battery is actually a collection of several individual voltaic cells connected together in series. Each cell, which stores about two volts, consists of two lead plates immersed in a mild solution of sulfuric acid. When an electric current is passed through the cell, a reversible electrochemical reaction takes place that stores energy within the cell to be released on demand at a later time.

As simple as it first sounds, the lead-acid energy storing process is

quite complex. Lead-acid batteries are sensitive electrical components which require specialized care. This is particularly true of their charging requirements. Let's see how they work.

Lead-Acid Chemistry

Charging begins when you apply voltage across the plates of the cell. This initiates a chemical reaction that changes the chemistry of the electrolyte and plates in the cell. The rate of this reaction is controlled by the charging current. The more powerful the current, the faster the reaction takes place. In this respect, the lead-acid battery and solar cell are in agreement: they are both current-operated.

As more and more charge is put in the cell, though, the more saturated the chemical soup becomes. Finally, it reaches a point where the chemical

reaction equalizes; it simply can't accept any more current. Equalization occurs when most of the sulfate ions (which are absorbed from the sulfuric acid solution during the discharge cycle and become embedded in the lead plates) are driven from the plates and forced back into the solution.

At this point, the plates take on metallic properties and begin behaving like electrodes. We now have a condition where two electrodes are immersed in an aqueous solution — the perfect situation for electrolysis. What is electrolysis? What does it have to do with bikini lines? Not a lot, when it comes to batteries.

Electrolysis is a process that breaks down a compound into one or more of its elements. A classic example from high school chemistry is connecting two carbon rods to a battery and placing them into a solution of ionized water to produce hydrogen and oxygen gas.

In fact, that's just what happens in a lead-acid battery when it becomes saturated. The charging current breaks down the water in the sulfuric

acid into its elemental components of hydrogen and oxygen. You may have noticed this process without even knowing it. It's commonly referred to as "boiling" of the battery. This misnomer comes from the percolating effect displayed by rising gas bubbles. More properly, the effect is called gassing.

Gassing usually occurs when approximately 70 to 80 percent of the total charge has been replaced. If left to continue, gassing will cause permanent damage to the battery.

Consequently, the charging current has to be reduced after gassing begins. This is why we need a charge controller — to keep the electrolytic reaction down to safe levels.

Here's where the battery charger (or charge controller, as it's called in photovoltaic parlance) comes into play. It knows when to sock it to the battery and when to back off. This final step in the charging process is called the finish current.

The finish current (no relation to the Swedish lingonberry) slowly adds the

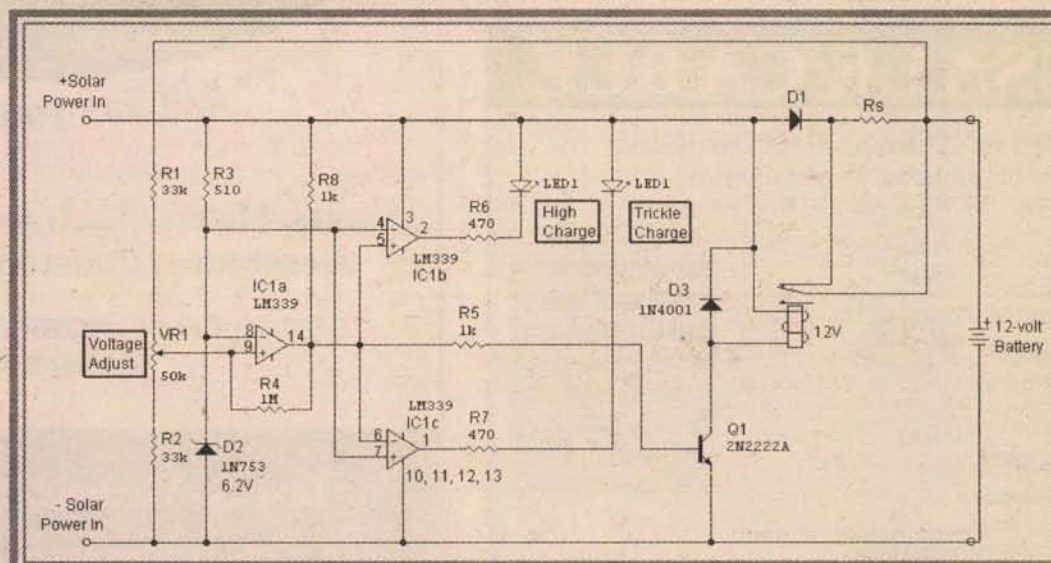
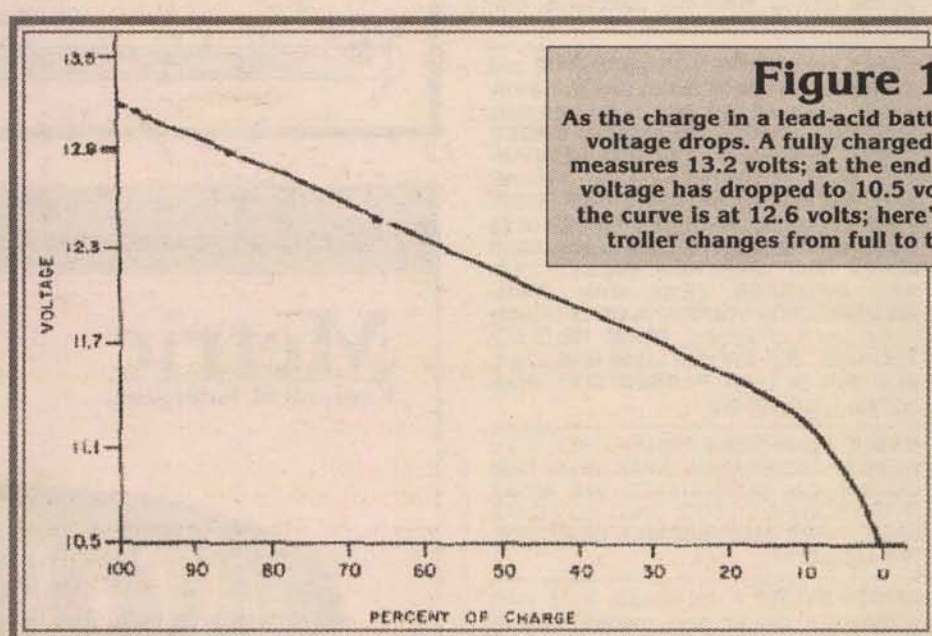


Figure 2

The schematic of our lead-acid charge controller. See Table for D1 and Rs values.

THE NUTS & VOLTS SOLAR WORKSHOP

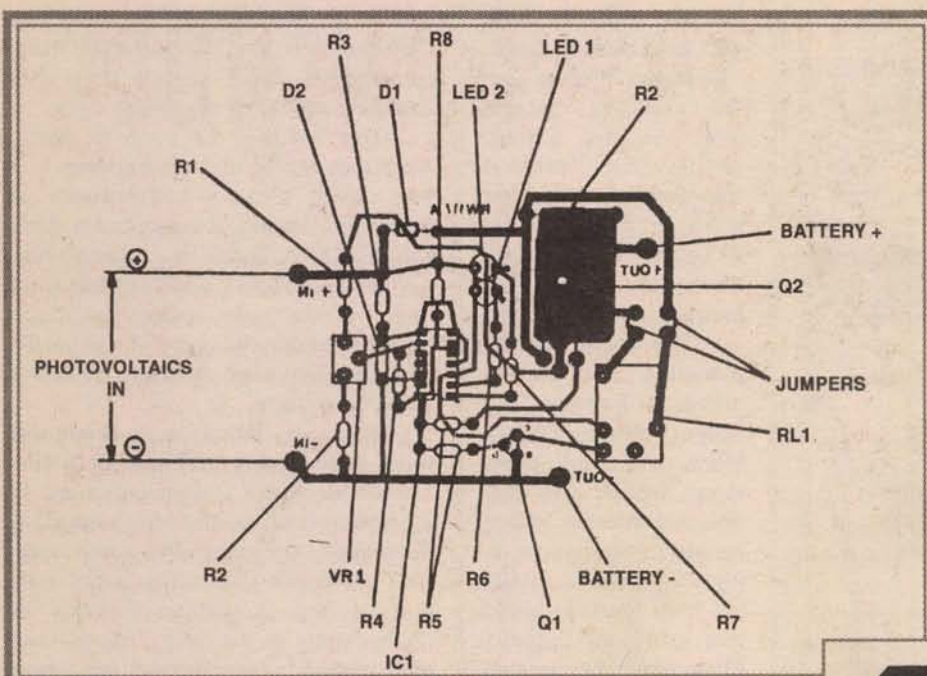


Figure 3

The parts are placed on the circuit board like this.

last 20 percent of the charge to the battery while avoiding the severe gassing that is so damaging to the cell. After the battery is fully charged, it can be removed from the current. Due to internal forces (specifically, impurities in the electrolyte) though, the charge bleeds off at a rate of about 10 percent per month. Eventually, the entire charge will be dissipated altogether. Consequently, the battery is usually left on a "trickle" charger, one that replaces what the battery itself consumes.

The charge controller we're constructing here does all three jobs: full-rate charge, finish, and trickle. How, you ask, does it know when to do which? By monitoring the battery's voltage.

How It Works

Let's take a typical 12-volt battery, like the kind in your car. When it's fully charged, the battery measures 13.2 volts. As the charge is used up, the voltage decreases. The region of interest to us lies between the 70- and 80-percent points (Figure 1). This is where gassing normally occurs, and where we must shift gears in the charging process. For a 12-volt battery, this point is about 12.6 volts. Below 12.6 volts, it's full speed ahead; above that we go to the finish or trickle mode.

The controller circuit, shown in Figure 2, is a two-step charger. Monitoring the battery voltage is a comparator, IC1a. The function of a comparator is to compare an unknown voltage to a reference voltage, then make a decision about the two. The reference voltage is derived from a zener diode, D2,

and fed to the comparator's inverting (-) input. This sets the triggering level for the circuit.

Because 12.6-volt zeners are not a common commodity, the battery's voltage is divided by resistors R1, VR1, and R2 so that it falls within the range of the very stable 6.2-volt zener. This voltage is input to the comparator's non-inverting (+) input. VR1 fine-tunes the trigger point. When the compensated battery voltage dips below the limit set by zener diode D2, the output from the comparator goes negative. Conversely, if the battery voltage is above the reference, the output swings positive. This voltage swing provides us with the control we need to maintain proper charging currents.

The charging current to the battery is controlled by a relay. The output from the comparator drives the relay through Q1. When the comparator output is negative (indicating that the battery's charge is on the low side), no current flows through the base of Q1, which places a full charge on the battery. Diode D1 prevents the battery from discharging through the charger

and solar cells at night.

As the charge increases, so does the battery voltage. When the battery reaches 12.6 volts, the comparator goes positive, which permits current to flow through the base of Q1. This engages the relay. The charging current from the photovoltaics must now force its way through a limiting resistor. The value of this resistor is selected to allow only two percent of the battery's capacity to reach the cells. The finishing current normally runs two to five percent of the battery's capacity. For example, if you have a 75 amp-hour battery, the kind you find at any auto parts store or auto service center, the finishing current can be anywhere from 1.5 amps to 4 amps.

Trickle charge current normally ranges from one percent to two per-

cent of the battery's capacity, which, in turn, reduces the charging current. However, the output voltage of the battery is dependent on more factors than just the amount of charge in the cells. It's quite conceivable that the voltage could drop by a hundredth of a volt to 12.59 during the switching operation because of changing charging conditions.

What happens now is that the relay flip-flops while the controller and battery try to make up their minds. To eliminate "hunting," as it's called, a small amount of positive feedback is introduced into the comparator via R4. As a result of the hysteresis, a larger change must take place before the comparator reacts. Yes, it will still downshift at 12.6 volts, but it won't go back to full throttle until the battery

voltage drops below 12.5 volts. Hunting and relay chatter are now eliminated.

Since the LM339 contains four comparator devices, and the charger uses only one, I couldn't resist adding a frill: a charge monitor. The monitor is made up of two comparators and a pair of light-emitting diodes (LED). Notice that the inverting input and non-inverting input of each of the two "indicator" LEDs are connected to the output of the comparator. The other two inputs are hard-wired to the zener diode. When the charger controller is in the high-charge mode, the upper comparator is active and LED1 ("High Charge") lights. In the trickle-charge

mode, LED2 ("Trickle Charge") lights.

Construction

The controller is constructed on a printed circuit board. A foil pattern of the board is shown in Figure 4. Using the parts layout in Figure 3 as a guide, insert the components into their respective holes and solder them in place. Take care to orient the semiconductors properly to avoid pin reversal. The completed board should be put into an enclosure of some kind, preferably one that's watertight.

Only four connections have to be made to install the controller — two to the battery and two to the solar panel. After the controller is installed, you have to adjust VR1 so that it switches at the proper time. First, allow the battery to discharge a little bit. Now turn VR1 fully clockwise. This closes the relay contacts. With a voltmeter, monitor the voltage across the battery as it recharges. When the battery voltage reaches 12.6

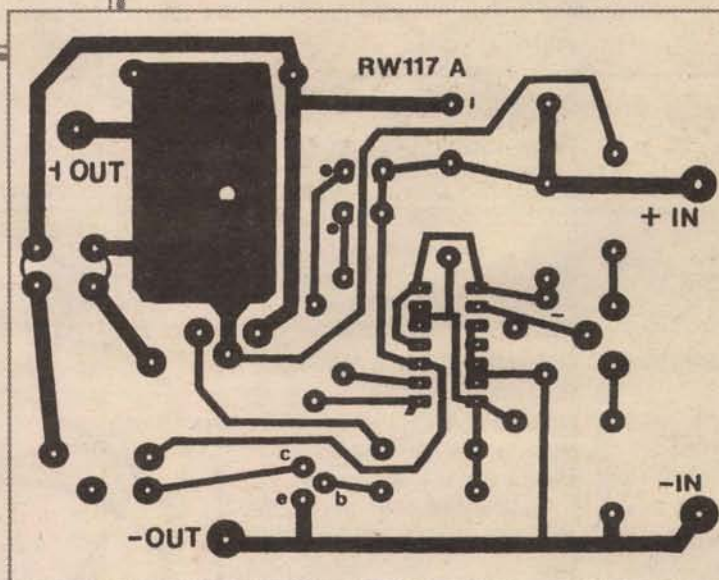


Figure 4

You can use this artwork to make the printed circuit board for the controller.

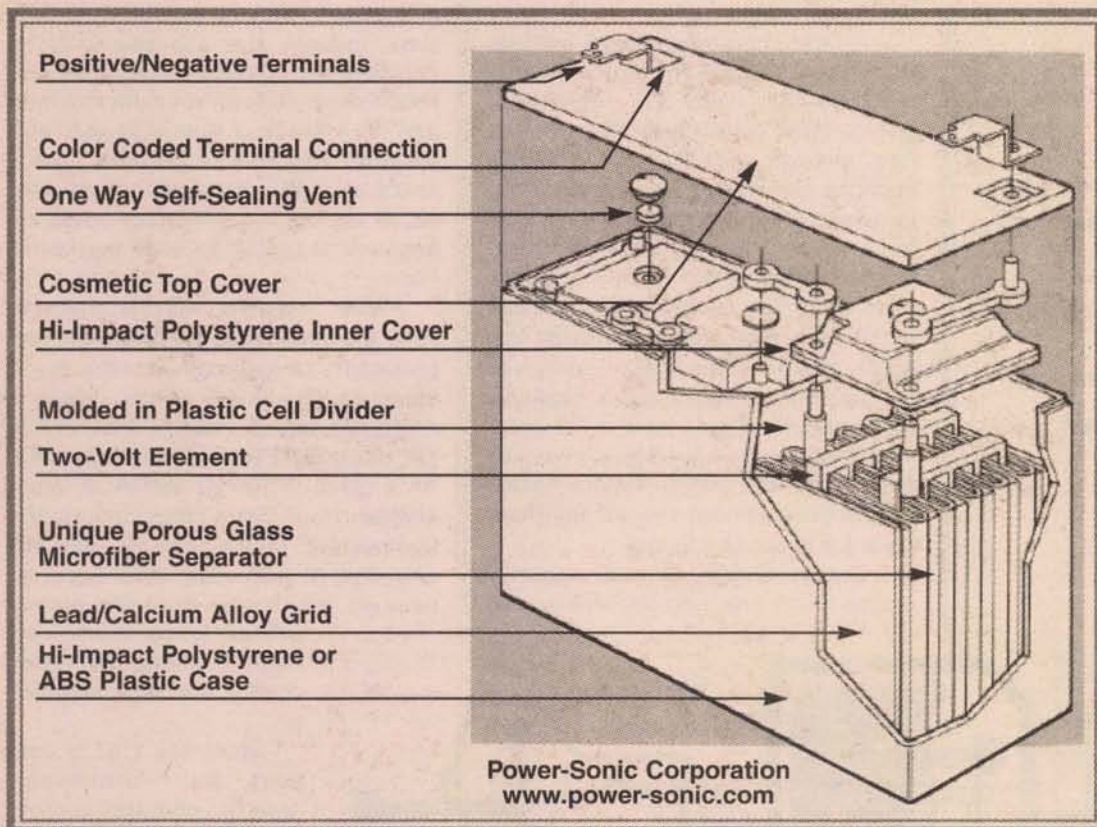
cent of the battery's capacity. Often the two, can be one and the same, which is what's happening here. Letting the two-percent level serve both purposes reduces controller complexity and improves its reliability. For other battery sizes, see Table 1. At charge currents above 10 amps, remove the jumper wires J1 and J2 and use RL1 to drive an external relay (Figure 3).

At the point where the battery voltage triggers the relay, there's a little uncertainty. For example, let's say the battery voltage has crept up to 12.6 volts — the crossover point. This forces

Table 1. Recommended Lead-Acid Battery Charging Currents.

Battery Capacity (amp-hours)	Maximum Charge Rate (amps)	Trickle Charge Rate (amps)	Rs Value (ohms)	Rs Wattage Rating (watts)	D1 Blocking Diode
5	1.0	0.1	23	1/4	1N4001
10	2.0	0.2	12	1/2	1N5400
15	3.0	0.3	8.7	1	1N5400
25	5.0	0.5	4.6	1	GI750
50	10	1.0	2.3	3	MBR1045
75	15	1.5	1.5	5	MBR3045
100	20	2.0	1.2	5	MBR3045
150	30	3.0	0.7	10	MBR3045

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positive plate is filled with lead dioxide paste. The negative plate contains spongy metallic lead. As the battery charges, the dioxide is transferred from the positive plate to the solution. Discharging the battery reverses the process.

The most readily-available sources of lead-acid batteries are Sears, Montgomery Ward, or the auto parts store around the corner. Automotive batteries are designed to supply high-peak currents for brief periods while you crank an engine. They have thin pasted plates that shed their material at the drop of a hat. They're made to discharge only 10 to 20 percent of their energy

and to be discharged fully each day. Unfortunately, the plates are still made from paste, which means they shed material with each discharge cycle.

The fact that the paste is thicker than that found in auto batteries is a plus, even though it eventually all flakes off, leaving you with but a skeleton of a plate. Thankfully, it won't happen nearly as soon, which makes them useful in most solar applications. Look for them under the guise of marine/RV or trolling batteries, at about \$50.00 to \$100.00 a piece.

Stationary batteries are made with thick solid plates, not pasted plates. They're designed to be used as standby power, such as the kind needed to keep your computer alive when some idiot plows into the corner power pole, and are kept in a state of nearly full charge most of the time. Nonetheless, their rugged construction lets them discharge very deeply time and time again. Unfortunately, stationary batteries aren't commonly available, and when you do find one you'll need a truck to get it home because they're

Figure 5

This is the construction of a typical 12-volt lead acid battery.

volts, advance VR1 until the relay just pulls in. That's it!

That's All, Folks

Well, that's all I have space for this month. Next month's project will be a NiCad/NiMH battery charger — the kind of battery you find in a notebook PC or rechargeable flashlight. 'Till then, fire up the soldering iron, have fun, and find time to sit in on the Classroom lecture.

The Classroom

All About Lead-Acid Batteries

Today's lecture is on sizing your storage batteries to the photovoltaic panels. Batteries come in all shapes and sizes, and without them life would be a lot different. Can you imagine

yourself without a flashlight? How about no radio during an emergency? And I'll bet more than a few teenagers can't walk without a Walkman.

Let's first talk about the different types of lead-acid batteries on the market, and how they compare. The choices include wet lead-acid, gel-cell, and AGM (Absorption Glass Mat) battery types. Then I'll show you how to calculate the size of solar panel you'll need to keep the battery charged.

Wet-Cell Lead-Acid Batteries

Because of cost and availability, wet (or flooded) lead-acid batteries are typically the storage media of choice for most photovoltaic installations. This battery generally has three or more two-volt cells, connected in series, which are immersed in an electrolyte solution of dilute sulfuric acid. To increase surface area and power, the electrode is made up of several smaller plates which are wired together (Figure 5).

Between the positive and negative plates are thin separators usually made of plastic that don't enter into the chemical reaction. Instead, they're used to keep the plates from touching and shorting out the cell. The separators are porous so that electrolyte can flow through them.

Each plate has a framework, or grid, made of a hard alloy of lead and antimony or calcium. The grid of the

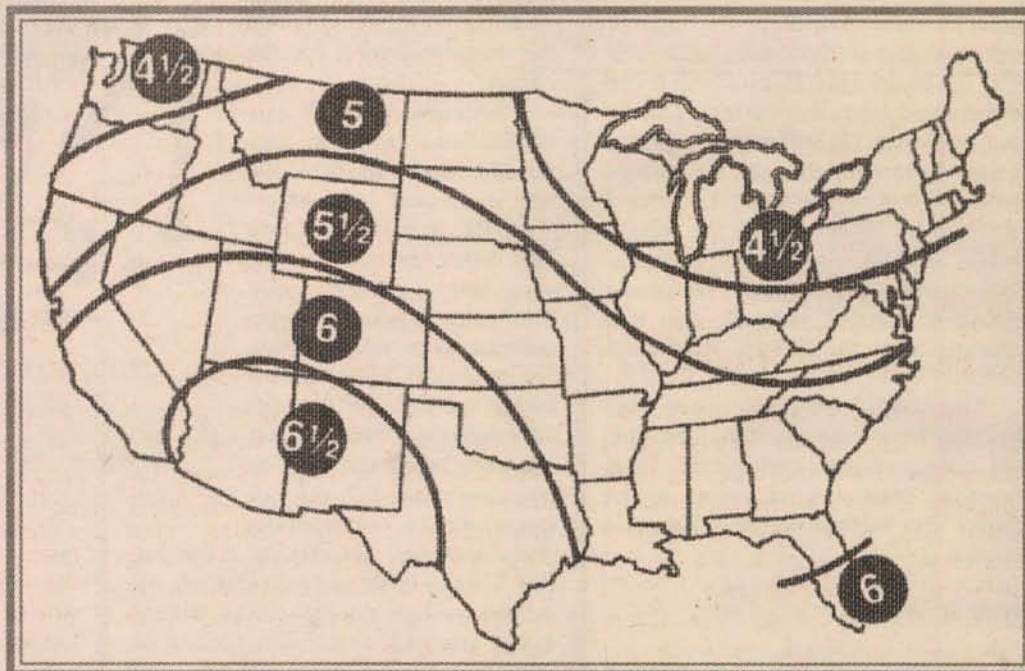


Figure 6

The amount of sunlight falling on the earth varies from place. This map shows the average practical amount of sunlight to expect for most of the United States over the course of a year.

each cycle, and are expected to be recharged immediately after discharge.

Deeply discharging an auto battery even 20 to 30 times will shorten its life if not end it. Auto batteries like to be pampered, giving up very little and asking a lot (like my cat). When put under stress — especially deep discharge — the plates buckle and quickly fall apart. Nonetheless, they find a lot of use in solar applications because they're cheap and easy to find. Just use kid gloves.

Traction batteries — like the kind used in electric forklifts and golf carts — are made with thick pasted plates and very rugged separators. They're designed to withstand heavy vibration

big and heavy. Prices start at \$100.00 and soar quickly.

Most lead-acid batteries require an occasional watering to replace the liquid lost by gassing (see The Workshop) and evaporation. Decreasing liquid level decreases battery capacity, and exposes the top of the plate to the air, where it quickly oxidizes and robs the battery of further capacity even after a water refill. Battery maintenance is done by removing a "filler" cap covering the cell and adding water, not acid.

Hydrocap Corp. (305-696-2504) makes a replacement filler cap that contains a catalytic material which captures the escaping hydrogen and oxygen gasses and recombines them

Charge Controller Parts List

Resistors

R1, R2 — 33K
R3 — 510 ohms
R5, R8 — 1K
R6, R7 — 470 ohms
Rs — see Table 1
VR1 — 50K potentiometer

Semiconductors

D1 — see Table 1
D2 — 1N735
IC1 — LM339
LED1, LED2 — red or green LED
Q1 — 2N2222A

Miscellaneous

RL1 — Relay (Radio Shack 275-248)

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back into pure water which dribbles back into the cell, thereby greatly reducing the required maintenance. The sealed automobile battery uses a similar recombination process.

During periods of heavy charging, though, the gas pressure can build up faster than it can be converted into water. When the internal pressure exceeds safe limits, a valve opens and the gasses vent to the atmosphere where they're lost forever.

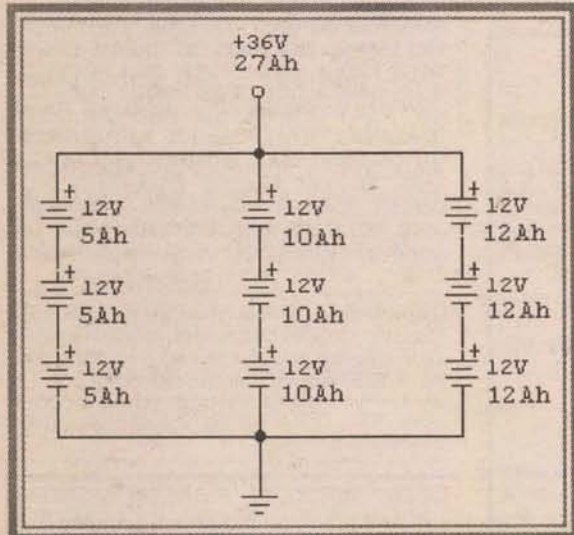


Figure 7

Batteries with the same amp-hour rating are placed in series to increase the voltage; batteries with the same voltage, but different amp-hour ratings can be wired in parallel to increase the total storage capacity of the battery bank.

Gel-Cell Lead-Acid Batteries

In an effort to make a rechargeable lead-acid battery that's totally maintenance-free, the Sonnenschein Company in West Germany developed sealed gel technology, commonly referred to as a gel-cell. Instead of sulfuric acid, the gel-cell uses a thick thixotropic gelled electrolyte (a material that goes from liquid to gel, like Jell-O, when you quit stirring it) with the consistency of candle wax once it sets up.

The gel-cell is a recombinant battery. This means the oxygen that's normally produced on the positive plate recombines with the hydrogen given off the negative plate to replace the moisture in the battery. The cell is pressurized and sealed using special valves (and therefore should never be opened). The oxygen is trapped in the cell by these special sealing vents, where the pressure forces it to the negative plate through tiny cracks in the gelled electrolyte for recombination. Although the battery is spillproof, and theoretically can be operated in any position, mounting it on its side or upside-down isn't recommended because the gel does creep and will clog the valve.

While you can buy gel-cells equal in capacity to wet cells, they cost a lot more. Consequently, gel-cell batteries are typically used in low-power appli-

cations where zero maintenance is a must, such as remote cabins and repeater sites. The battery in your car is probably rated at 75 amp hours (I'll explain amp hours later in the lecture) whereas the typical gel-cell weighs in at under 30 amp hours.

Gel-cells aren't as durable as wet-cell batteries because they require very accurate regulation to prevent overcharge and over-discharge. On the other hand, they're maintenance-free, never need watering or equalization charge, and won't freeze. Furthermore, they're particularly well suited for deep-cycle applications.

AGM Lead-Acid Batteries

In 1983, GNB (then known as Gould) revolutionized the battery industry by introducing the first large-capacity, sealed lead-acid battery — the AGM (Absorption Glass Mat) battery. This totally maintenance-free lead-acid battery is of the starved electrolyte type that uses a microporous fiberglass mat separator. This glass mat absorbs and immobilizes the acid — no gel needed here — while still keeping the acid in contact with the plates. This permits a fast reaction between

acid and plate material.

The separator mat also traps the gasses to provide the highest oxygen recombination efficiency. Because the mat is tightly wedged between the plates, it holds the plate's paste firmly in place and retards shedding. This, combined with an extremely low internal resistance, allows the AGM battery to deliver and absorb higher rates of amperage than other sealed batteries for faster deep discharge and recovery, yet display behavior comparable to that of conventional flooded electrolyte lead-acid batteries.

Originally developed for military aircraft use where power, weight, safety, and reliability are paramount, the AGM battery is quickly replacing the marine/RV and gel-cell battery in a broad range of applications — including photovoltaics. Expect prices to be slightly higher than for a flooded cell, but cheaper than for an equivalent gel-cell.

Matching The Photovoltaics To The Battery

For most efficient operation, the battery has to be matched to your photovoltaics. If the battery is too small, you waste a lot of potential solar power as the charge controller throttles back to trickle charge. If the battery is too large, it never gets fully charged, which shortens its life.

Battery capacity is measured in amp hours (Ah). Simply put, a 20 Ah battery can deliver one amp of current for 20 hours, or two amps of current for 10 hours (well, not exactly, but I'll take up that discussion in another session). Voltage is not a factor in the amp-hour rating. While a 48-volt battery will deliver four times the power of a 12-volt battery, it can sustain that power flow for only as long as its amp-hour rating lets it; therefore a 48-volt 20 Ah battery and a 12-volt 20Ah battery will run out of juice at exactly the same time.

Because of internal losses caused by heat and other factors, though, you have to replace more power than you take out when recharging the battery. How much more depends on the battery type.

Shallow cycle batteries, like the type used to start automobiles, are designed to supply a large amount of current for a short time and stand mild overcharge without losing electrolyte. Unfortunately, they can't tolerate deep discharge.

If they are repeatedly discharged more than 20 percent, their life will be very short. So when using these batteries in a photovoltaic system, you have to make sure you have enough solar power to keep these batteries topped off most of the time. For example, if you're using a 100 Ah battery, you need a solar panel with no less than an average 20 Ah rating.

Solar Insolation

The size of the solar panel will depend on your geographic location. As the earth orbits the sun, its axis isn't perpendicular to the sun, but inclined at an angle of 23-1/2 degrees. Consequently, the sun doesn't strike the earth straight on. Instead, it oscillates north and south of the equator during the course of a year. We notice its effects in the passing seasons.

The shifting of the sun's latitude during the seasons is quite predictable and easily compensated for. The map in Figure 6 shows typical hours of productive sunlight per day over the course of a year for most of the United States. The values range from 4-1/2 to 6-1/2 hours. This means that if you live in New Mexico, or example, you get two hours more solar power than you would if you lived in Seattle. (Down, class. I'll elaborate more on the effects of rain and fog in a future session. For now, trust the map.)

Let's now calculate how much power we need from our solar panels to keep our 100 Ah battery fresh. First, let's use a New Mexico scenario. If we take out 20 amp-hours each day from the battery, the solar panels will need to replace about 30 amp-hours on average. With 6-1/2 hours of sun, this translates into

$$\text{Current (amps)} = \frac{\text{amp-hours (30)}}{\text{time (6.5)}}$$

or 4.6 amps. If we're charging a 12-volt battery, that requires a 55-watt solar panel (like the ARCO Solar model M55). If we plug the values for Seattle into the formula, the answer is 6.7 amps, or an 80-watt solar panel.

Temperature has a significant effect on lead-acid batteries. At 40 degrees F, they will have 75 percent of their rated capacity, and at 0 degrees F, their capacity drops to just half. Consequently, a wet-cell lead-acid battery should be sized at least 50 percent larger than the load requirements.

Going back to our 100 Ah example, this means you'll want to have 150 Ah capacity. Gel-cell and AGM lead-acid batteries are much more temperature-tolerant, and can be sized to 10 percent larger than the amount required. Just remember that you still need to replace the power used every day, or run the risk of premature battery death.

How To Build A Battery Bank

Very often, it's impossible to find a single battery to do the job for you, and many times you don't want to put all your eggs in one basket. Which is why most photovoltaic systems use modular batteries, or battery banks, as they're often called. This method lets you upgrade the system as your needs grow, and removes the risk of catastrophic failure should one battery fail. Batteries can be added to the bank in two different ways: in serial and/or in parallel (Figure 7).

In a series string, batteries of like amp-hour capacity are connected to increase the voltage of the bank. The positive terminal of the first battery is connected to the negative terminal of the second battery and so on, until the desired voltage is reached (think Christmas tree lights). The final voltage is the sum of all battery voltages added together (six cells equals 12 volts; a dozen cells, the equivalent of two car batteries, is 24 volts) while the final amp-hours rating equals that of the smallest battery, which is why you shouldn't mix 50 Ah batteries with 100 Ah batteries.

In a parallel bank, batteries of identical voltages are connected to increase the amp-hour capacity of the bank. The positive terminals of all batteries are connected together, and all the negative terminals are connected together.

The final voltage remains unchanged while the capacity of the bank is the sum of the capacities of the individual batteries. Here you can mix and match battery types; a 100 Ah 12-volt battery in parallel with a 50 Ah 12-volt battery results in a 150 Ah 12-volt battery.

I don't know about you, but I've had enough theory for one day. Besides, this lecture has bored Raj to snores. Class dismissed — please wake Raj on your way out. **NV**

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MMWM5

KIT \$34.95

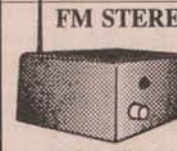


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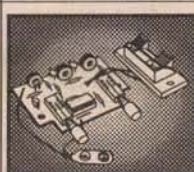
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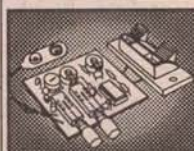


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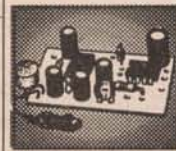


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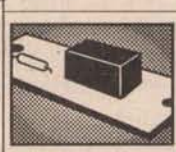
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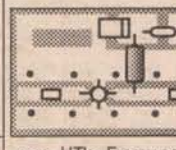


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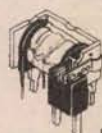
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CAT# MB-53 \$15.00 each

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Marquardt # 1050.0141A Small, normally-closed switch rated 2 amps @ 125/250 Vac. Prepped with 5" long wire leads and 2 contact socket connector. Body size: 0.78" X 0.4" X 0.25". UL and CSA listed. Large quantity available.

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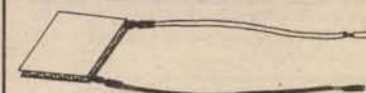
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Nidec, Gamma 28 # A34342-55APP 12 Vdc, 0.18 amp brushless centrifugal blower designed for applications with space limitations. This small, lightweight blower features permanently lubricated ball bearings and a quiet thermoplastic housing. 3" diameter X 1.18" thick. Output port is 1.4" X 1". 5" leads.

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80387SX-20	\$17.95	8751H	\$9.95
80387SX-25	\$19.95	8752	\$13.95
80387DX-20	\$17.95	8755	\$6.95
80387DX-25	\$24.95	MC68020RC20	\$14.95
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All parts, all socket pulls must be cleaned & tested. *Note: Speed selection available at additional charge and all parts subject to availability.

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27C64	\$1.25	27C1001	\$6.50
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41256-10\$1.35 Ea.

NEW ALPS 2.88 MEG 3.5" FLOPPY DISK DRIVE FOR 755 SERIES THINKPAD LAPTOP

New 2.88 Meg 3.5" floppy disk drive mfr. by Alps for IBM Thinkpads 755 Series computers. This drive replaces the 1.44 Meg drive by transferring it into the original mounting bracket (5 min.) and it will be auto-detected when the computer is started. Supports 720K/1.44Meg/2.88Meg standards. TP755/2.88 (IBM P/N 1619718)\$59.95 Ea.

MICROSOFT VISUAL FOXPRO PROGRAM STANDARD EDITION ON CD-ROM

New Microsoft Visual FoxPro database program Version 3.0. Full, not upgrade version for Windows 3.1 (16 bit, but runs on Win95 also). A full relational database development system. No manuals included, all documentation online.
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Seagate's Medalist XE series 540 Meg ST-3660A hard disk drive. Voice coil actuator, thin film head, spindle speed 3,811 RPM, 8msSec. Access time, 120K buffer. Full Cap. 1057 Cyl/16 heads/63 sectors. ST-3660A Seagate\$119.95 Ea.

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Pulled from working equipment 1.44 Meg. 3.5" in 5-1/4" mounting bracket. 30 day guarantee. 5-1/4" half height off-white color face plate. Interface: 34 pin & 4 pin power.
Sony MP-F17W-70D\$19.95 Ea.

NEW 2X CD-ROM KIT WITH 5 CD TITLES

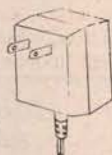
This CD-ROM kit comes complete with the following: 1 IDE 2X Caddy Less CD-ROM Drive Model #CR-563-B, 8-bit ISA interface card, data and audio cables. (Note: speakers not included.) Software titles included: Mayo Clinic Family Health Book, Interactive Edition Multimedia Encyclopedia, US and World Atlas, Mad Dog McCree arcade game, Mario Is Missing game.
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Input: 117 Vac 50/60 Hz. Outputs Available.



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12Vdc 100Ma		\$1.25 Ea.
12Vdc 200Ma		\$1.50 Ea.
12Vdc 500Ma		\$2.95 Ea.
12Vdc 600Ma		\$3.95 Ea.
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This board is your basic super VGA video board with 1 meg of DRAM type memory. (ISA BUS TYPE) Core Logic Chip: WD90C31-ZS-00-02. Resolution/Color: 640x480/256C, 800x600/256C, 1024x768/256C, 1024x1024/16C. Note: Software drivers included with board. Windows 3.1, VESA, Autocad, etc.
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New Cyrix FastMath coprocessors for 80386DX16-33 systems. This FPU unit is used in place of Intel's 80387DX16-33 part. Originally priced at \$100.00, a steal \$10.95. Case: 68 pin grid array. Cyrix CX-83D87-33-GP\$10.95 Ea.

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5-1/4" half height Panasonic M# JU-455. Black face plates only. P/N: JU-455\$9.95 Ea.

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Brand new OEM/Bus Toaster PCMCIA SCSI-2 adapter card for portable computers, made by New Media Corp. This card was manufactured for a large computer company and has its logo on it, but it is a full function product. Unit comes with ASPI driver software only. You must have your socket service software for your computer to use this product. Note: The Bus Toaster cable ends in a high density DB50 SCSI-2 connector. You may need an adapter for your particular needs.
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The AE-2/T Ethernet adapter is a network card for thick Ethernet and 10BASE-T cables. It is compatible with any Ethernet system and is Novell NE2000 compliant. Bus Type: ISA 8 or 16 bit. Data Transfer: 10 MPS. Programmable Interrupt: 2, 3, 4, 5, 6, 7, 10, & 15 AE-2/T 5.0 ISA Adapter\$24.95 Ea.

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1 MEGX8-80 30P SIMM (8 chip)\$7.95 Ea.
1 MEGX8-10 30P SIMM (8 chip)\$6.95 Ea.

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New Standard 1.44 Meg 3.5" floppy disk drive. Manufactured by Teac, Model #FD-235HG. Face plate color: Beige. 34 pin interface connector with 4 pin power. FD-235HG Teac 1.44M\$32.95 Ea.

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SDP5-10 SUNDISK\$199.95 Ea.

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New 12Meg memory up-grade module for NEC Versa series notebook computer. Made by Kingston for models E, V, M. 3.3V technology.
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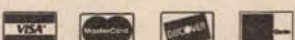
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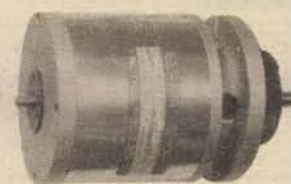
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Nuts & Volts Magazine/December 1996 55

If you are considering the purchase of an oscilloscope for the first time, or thinking of buying a better instrument than the one you have now, here is the information you need to know on how to select the right scope for your needs.

How Much Scope is Enough?

Part 1

by Jeffrey Mazur

Few things can beat electronics when it comes to getting faster, better, and less expensive every year. As more and more devices go electronic, they also become more complex. And this often makes them more difficult to design and troubleshoot.

Computers have become quite useful for simulating electronic circuits and many designs are now done this way. A lot of testing and circuit debugging can be done on a circuit without ever wiring up a single resistor or capacitor.

But at some point, the circuit must be tested in the real world to see if it really works like the computer simulation. And, with few exceptions (e.g., automotive electronics), when something stops working, the repair shop cannot expect a computer to tell them what's wrong. Only tried-and-true troubleshooting using traditional test equipment will repair the malfunctioning device.

When it comes to test equipment, the quintessential tool is still the oscilloscope, which allows a designer or repair technician to

see exactly what's happening in a given circuit. As electronic technology has grown more powerful and sophisticated, so too has the need for faster and better oscilloscopes.

Fortunately, since the oscilloscope is also an electronic device, the same advances in electronic technology can be applied to build better oscilloscopes.

For example, the trend toward digital electronics has driven almost all but the lower end scopes to be digital. The major manufacturers such as Hewlett Packard and Tektronix have virtually eliminated analog scopes from their product line. But lower cost analog scopes are still available; indeed many can be found advertised on the pages of this very magazine.

You may be wondering then, which oscilloscope is best for the job you want to do. For example, you may be using the scope to design audio circuits or you might need a scope to repair computers. Will the same instrument work equally well for both applications?

In this article, we will explain the features of analog, digital, and specialized oscilloscopes, as well as how they are used.

OSCILLOSCOPE SELECTION

Storage vs. Non-storage

Many criteria go into the decision of selecting an oscilloscope. Certainly, the need (or lack thereof) for waveform storage is one factor. For most general-purpose use, a non-storage scope will do; to catch elusive one-time events, low repetition rate signals, and many digital waveforms, however, usually requires a storage scope.

Early storage scopes were analog. A special display screen or Cathode Ray Tube (CRT) with very long persistence (sometimes variable all the way up to infinite) was used to "store" the waveform as a visible trace on the screen.

Today, digital circuits are used instead to sample the waveform and store its values in conventional memory circuits. The waveform can then be continuously read out from memory to create the display. These digital storage scopes (DSOs) often add cursors for accurate voltage and time measurements and perform other mathematical functions on the acquired waveform for more advanced analysis.

In choosing any scope, one of the most important specifications is the overall bandwidth or frequency response of the vertical channels. When selecting a DSO, there are a number of other specifications to consider: repetitive vs. real-time

bandwidths; digitizing rate; amount of memory; and vertical resolution (i.e., number of bits per sample).

Be careful when comparing specifications, however — manufacturers do not always use the

same criteria when rating their scopes.

Other Features

Vertical sensitivity, number of channels, triggering capabilities, and so forth all go into the decision-making process. Other specialized functions, such as computer and printer interfaces, spectrum or mathematical analysis, digital readouts, and special triggering options, will affect the selection of the right scope.

For example, when servicing television equipment, a TV line and field trigger capability would be essential. Digital storage scopes have other considerations such as record length and interpolation modes.

As circuits get more complex and operate at higher frequencies, the specifications for a scope become more important. As previously mentioned, there has been a dramatic shift towards digital storage scopes; but for the hobbyist, old-fashioned analog scopes still hold their own.

Frequency response — one of the major criteria on which a scope is rated — is one specification which seems to get better every year. While this may in part be due to the availability of faster semiconductors and better construction techniques, it is also driven by the need for faster scopes to troubleshoot the ever increasing clock

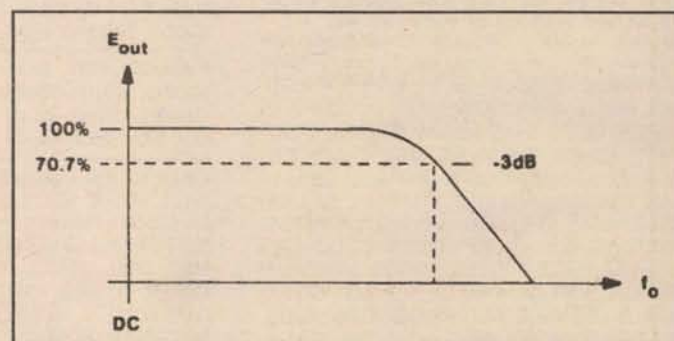


Figure 1. Typical frequency response curve of an oscilloscope vertical input.

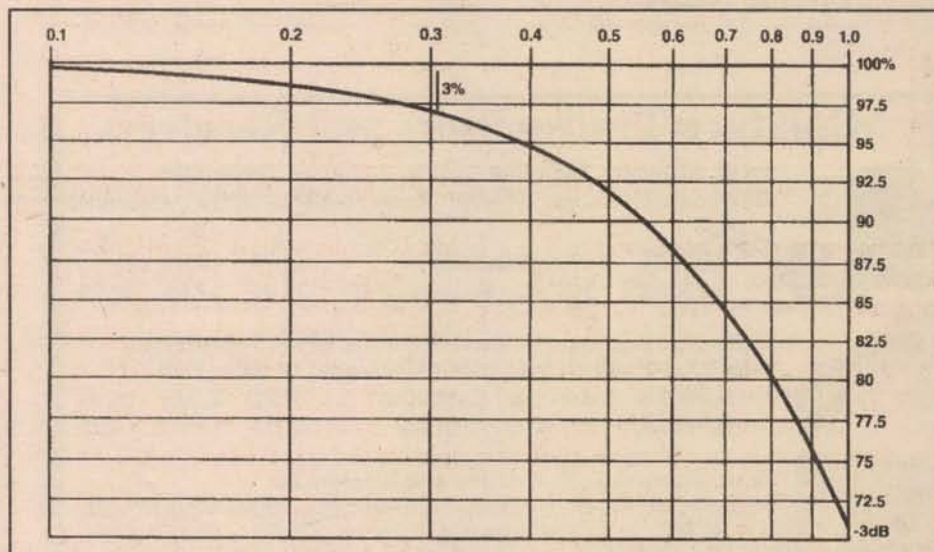


Figure 2. Normalized frequency response curve showing high-end roll-off. Note that for an error of less than 3%, the measured frequency must be less than 30% of the oscilloscope's rated bandwidth.

How Much Scope is Enough?

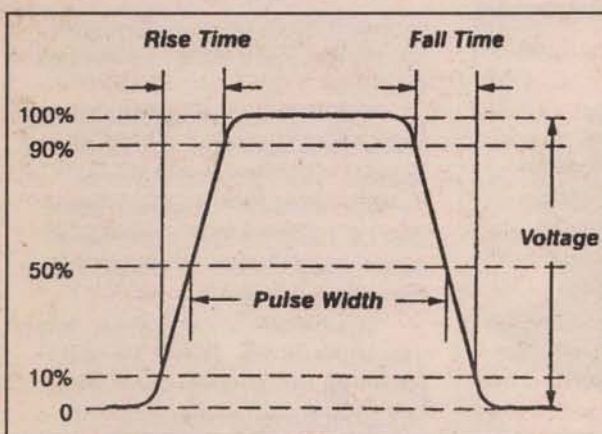


Figure 3. Risetime and pulse width measurement points.

rates found in digital circuits (and to a lesser degree by analog RF circuits which also continue to reach new limits).

Because of these factors, it

the oscilloscope input has several effects on signal fidelity. To begin with, let's see what happens when we observe a 1 V P-P (peak-to-peak), 100 MHz sinewave on an

Bandwidth

After finding the right features, the next most important consideration is the frequency range, or bandwidth, of the scope. Bandwidth specifications for analog scopes are pretty straightforward, but things get a little more complicated when applied to a DSO.

With analog scopes, as well as the input stages of DSOs, the overall bandwidth of

have a DC coupling switch). At the high end, the vertical amplifiers are designed for a Gaussian roll-off. Figure 2 shows an expanded view of the roll-off area.

Here it can be seen that for amplitude measurements to be accurate to within 3%, one must limit the frequency of the measured signals to roughly 30% of the rated bandwidth of the scope.

Thus, a 100 MHz scope is only really accurate for measuring signals up to 30 MHz (of course, when absolute amplitude measurements are not needed, the scope may be used to observe signals well beyond its 100 MHz rating subject to other errors such as described next).

For pure sinewaves, Figure 2 can provide a "fudge factor" which can be used to compensate for the

nals other than pure sinewaves, the frequency response of a circuit can affect more than the amplitude of the waveform. Digital pulses such as squarewaves, for instance, can be greatly influenced by frequency response.

Sharp transitions in a signal such as those found in the leading and trailing edges of squarewaves consist of many frequencies. These frequencies — or harmonics — extend way beyond the fundamental frequency of the squarewave itself.

The sharper the edge, the more important are the higher frequencies for reproducing this signal faithfully. If these frequencies are removed, or rolled-off, then the edges of the signal become less sharp, i.e., they become elongated and more rounded.

When dealing with pulses, a more useful way to describe frequency response is by specifying the fastest risetime which can be observed.

Risetime is defined as the time it takes a signal to change between its 10% and 90% values (see Figure 3). Risetime is approximately related to bandwidth by the following equation:

$$\text{Risetime} = 0.35/\text{Bandwidth}$$

Thus, our 100 MHz scope would exhibit a risetime of approximately:

$$.35/(100 \times 10^6) = 3.5 \text{ nS.}$$

When measuring risetime with an oscilloscope, remember that the observed risetime is actually dependent not only upon the signal being measured, but also on the risetime of the scope and, in some cases, even the probe:

$$Tr = \text{SQR}((Trs)^2 + (Tro)^2 + (Trp)^2)$$

Logic Family	Typical Signal Risetimes	Calculated Signal Bandwidth (-0.35/ t_{rise})	Measurement Bandwidth for 3% Roll-off Error	Measurement Bandwidth for 1.5% Roll-off Error
TTL	5 ns	70 MHz	231 MHz	350 MHz
CMOS	1.5 ns	230 MHz	767 MHz	1.15 GHz
ECL	500 ps	700 MHz	2.33 GHz	3.5 GHz
GaAs	200 ps	1.75 GHz	5.8 GHz	8.75 GHz

Figure 4. Bandwidth requirements for various logic families.

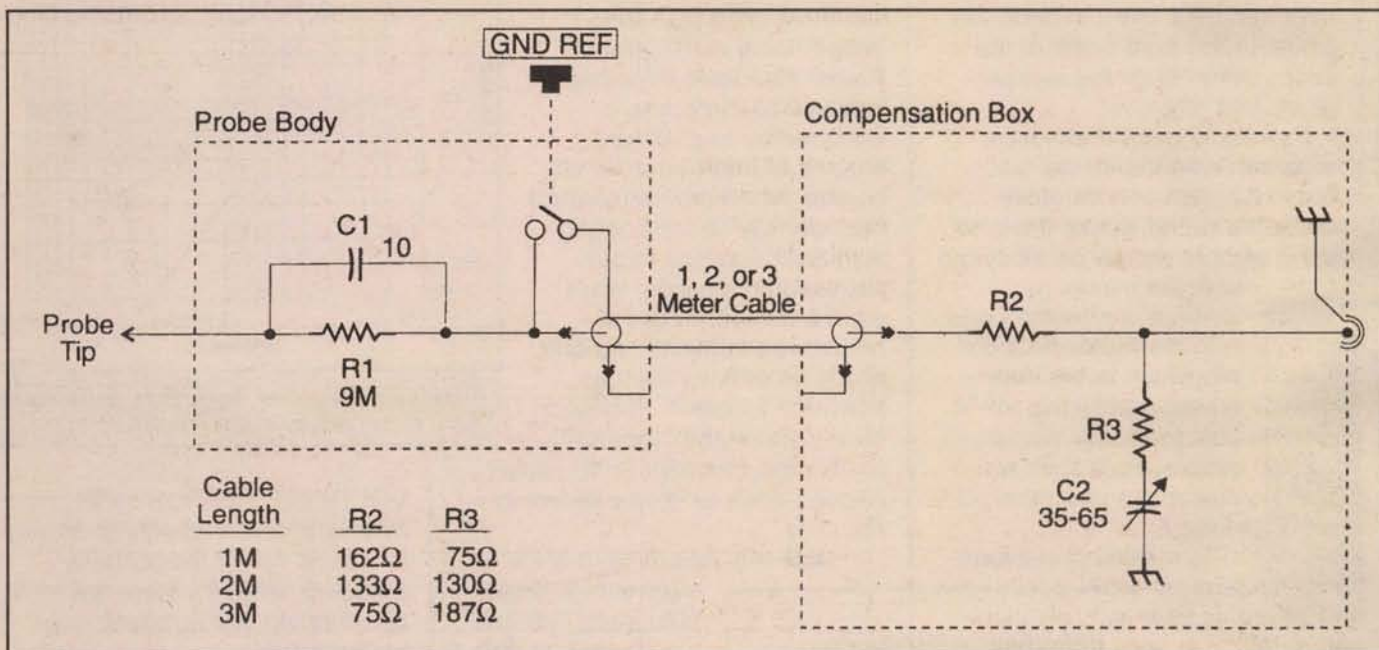


Figure 5. Schematic of a typical 10X passive probe.

has become more important to know what kind of signals you will encounter before selecting the right scope.

Are the signals repetitive or are you trying to observe a single-shot event? Will you be measuring complex analog signals or mostly digital waveforms (and then, what logic families are you likely to encounter)? Are you mainly interested in absolute amplitude measurements, time measurements, or are they equally important?

oscilloscope with a 100 MHz rating.

Although the scope is rated to have a bandwidth of 100 MHz, by definition, the observed amplitude will be down -3 dB. Therefore, the scope will only show a signal of approximately 0.7 V P-P — that is, there will be a measurement error of 30%.

This is detailed by the graph in Figure 1 which shows the typical response curve of an oscilloscope system. Note that the response is quite flat down to DC (most scopes

roll-off of the vertical circuits.

Some manufacturers suggest using a "five times" rule. This requires that you use a scope whose bandwidth is at least five times the highest frequency to be measured. This allows amplitude measurements to be made within 1.5%.

Risetime

When observing sig-

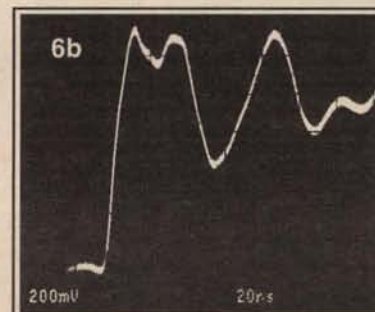
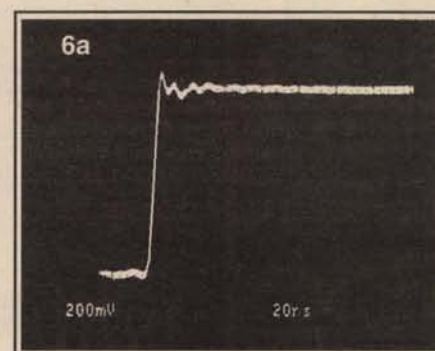


Figure 6. Pulse with a 6 nS risetime as seen on a 350 MHz scope with, a) a properly connected 10X probe and, b) ordinary hook-up wire.

How Much Scope is Enough?

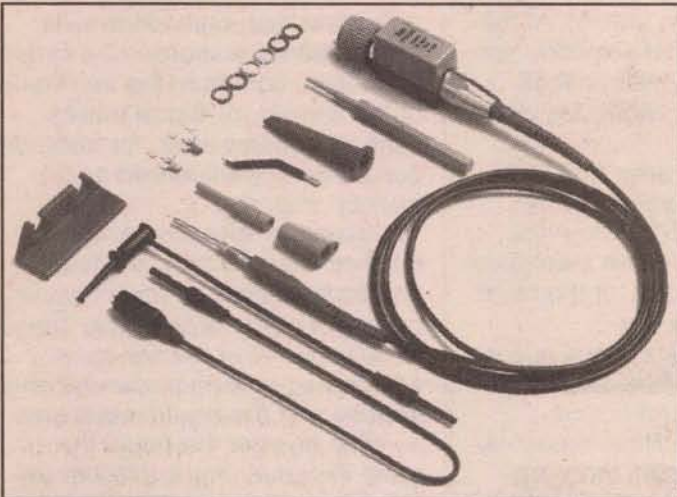


Figure 7. A high-quality miniature probe with accessories.

where

T_r = observed risetime of the signal
 T_{rs} = actual risetime of the signal
 T_{ro} = oscilloscope risetime
 T_{rp} = probe risetime

For digital circuits, it is usually quite simple to determine the bandwidth needed for accurate troubleshooting. Figure 4 outlines the typical risetimes of various logic families, as well as the band-

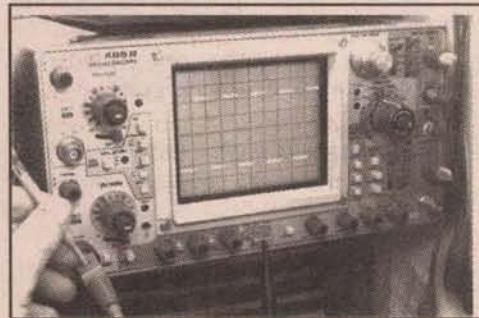


Figure 10. Performing the compensation adjustment on a 10X probe.

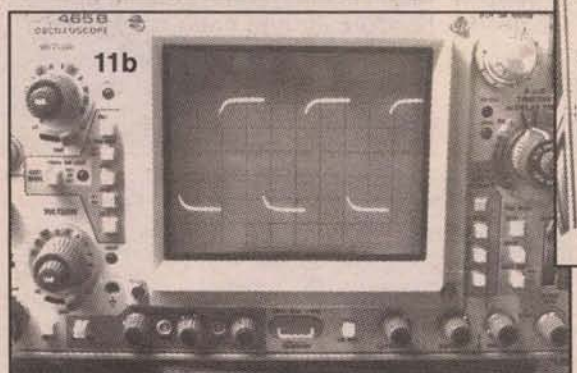
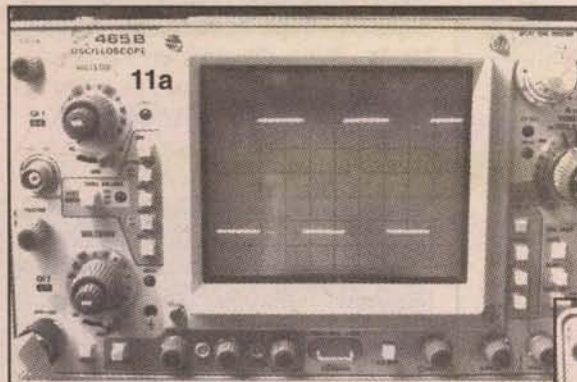


Figure 11. Display showing a) properly compensated, b) under compensated, and c) over-compensated probe.

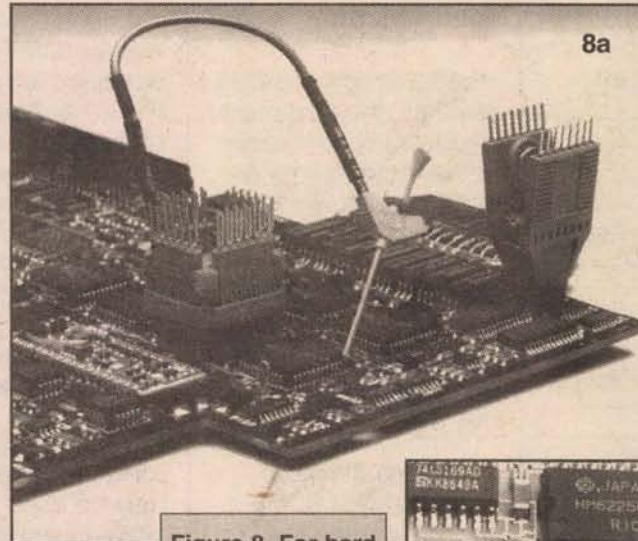


Figure 8. For hard to reach places, use a) an IC clip or b) a subminiature probe such as the SMT Klipchip.

width requirements for less than 3% or 1.5% amplitude errors. As the last column shows, for accurate measurements, it is usually best to follow the five times rule.

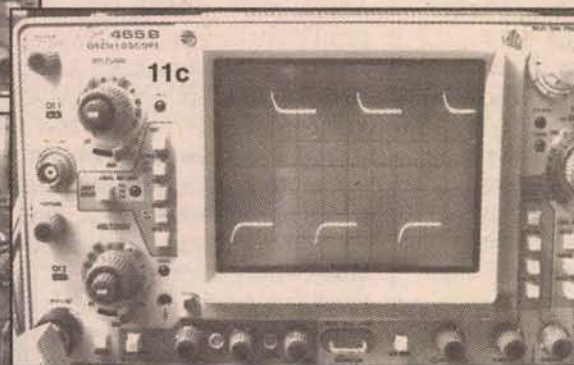
PROBE CONSIDERATIONS

Probe Specifications

As we have just seen, when evaluating the performance of an oscilloscope, it is important to include the complete measurement system. This includes whatever means is used to bring the signal to the front panel of the scope. Most likely this will be some sort of probe.

A probe is more than just a wire with a fine tip or clip-on hook. It is part of a carefully designed circuit whose job is to bring signals into an oscilloscope with the minimum amount of distortion and with the least affect on the circuit being measured. Part of this job is also to reduce pick-up of stray signals such as power line and other RF noise.

To reduce circuit load-



ing, most probes incorporate a 10X attenuator. This means that the signal which reaches the scope input is actually 1/10 the amplitude of the signal at

the probe tip. Figure 5 shows the schematic of a typical passive 10X probe.

At very high frequencies, the use of a quality probe is mandatory. Figure 6a shows what a pulse with a 6 nS risetime looks like on a 350 MHz scope using a 10X probe. Figure 6b shows what happens when the probe is replaced by two six-foot lengths of hook-up wire. Of course, when probing today's high-density circuit boards with SMT (surface mount technology) devices, you'll want a miniature, or sub-miniature probe with various probe tip options such as shown in Figure 7. For even harder-to-reach places such as IC pins, consider an IC clip or Klipchip such as those shown in Figure 8.

Note that all probes have a maximum voltage rating and that this value must be derated at higher frequencies. Figure 9 shows a derating curve for a typical X10 probe. It is readily seen that while the probe can handle 500 volts DC, the maximum amplitude of a 50 MHz sinewave must be less than 30 volts.

Probe Compensation

Before using an attenuating

probe, it must be compensated to match the input circuit of the oscilloscope.

This will ensure accurate attenuation and fidelity of the observed signals. Most scopes have a PROBE ADJUST terminal which can be used for this purpose. Any clean squarewave at about 1 KHz can also be used.

To check compensation, attach the probe to the adjustment terminal (see Figure 10) and select DC input coupling. Adjust the

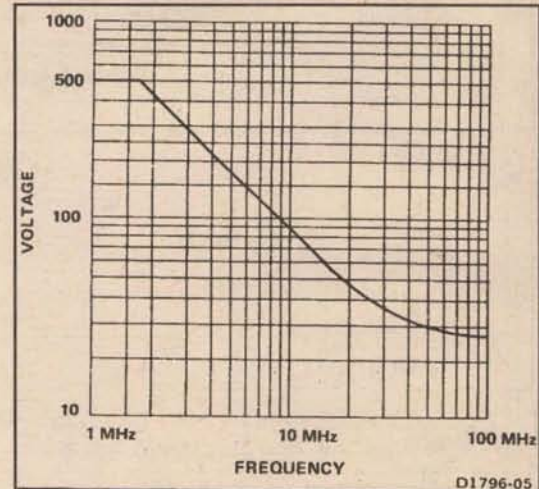
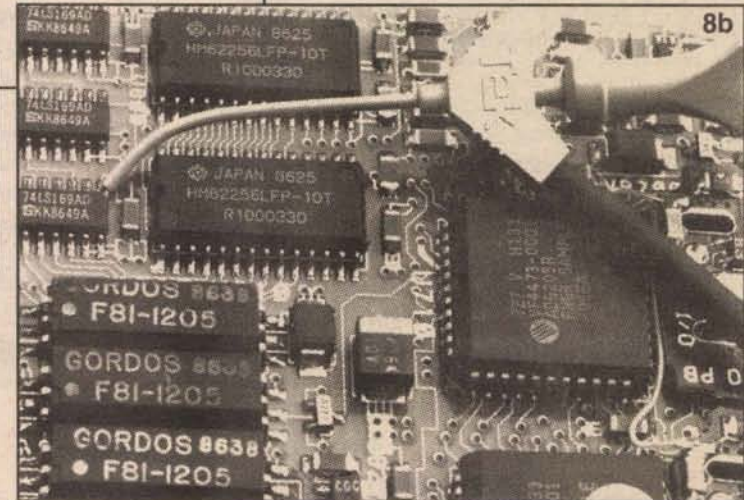


Figure 9. Voltage vs. frequency derating for a typical 10X probe.

VOLTS/DIV and POSITION controls to obtain a waveform similar to Figure 11a. If the probe is adjusted correctly, there will be little rounding or overshoot in the squarewave.

Figure 11b shows how the waveform will appear if the probe is under compensated; higher frequency components are being rolled off and therefore the fast transitions take on a more rounded appearance. In

Figure 11c, the probe is over-compensated and now the higher frequencies are being accentuated leading to overshoot on the transitions. Aside from distorting the actual waveshape, improper compensation can cause severe errors in level measurements as shown in Figure 12.

How Much Scope is Enough?

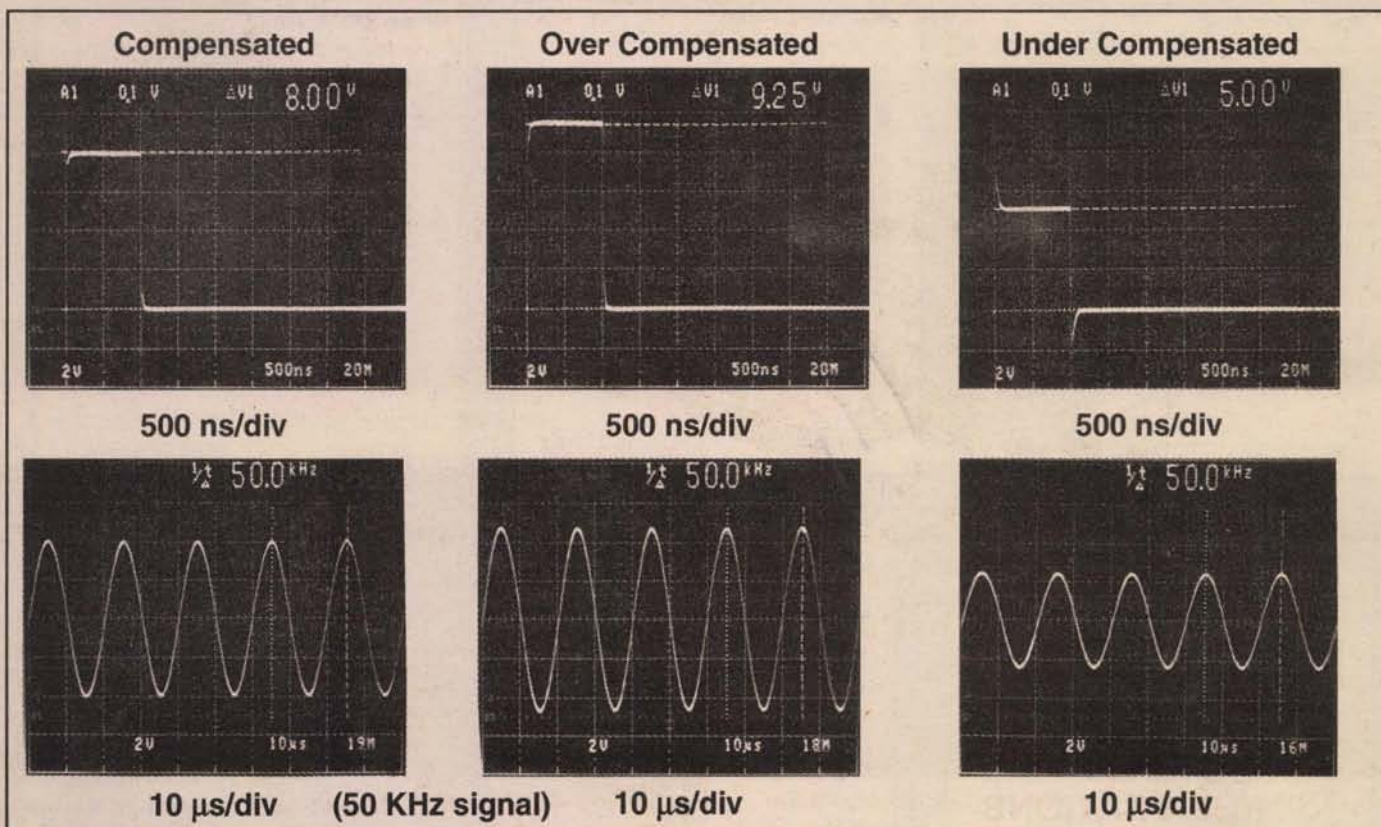


Figure 12. The effects of an improperly compensated probe on fast pulses and sinewaves. Note the large change in amplitude without much indication that there is an adjustment problem.

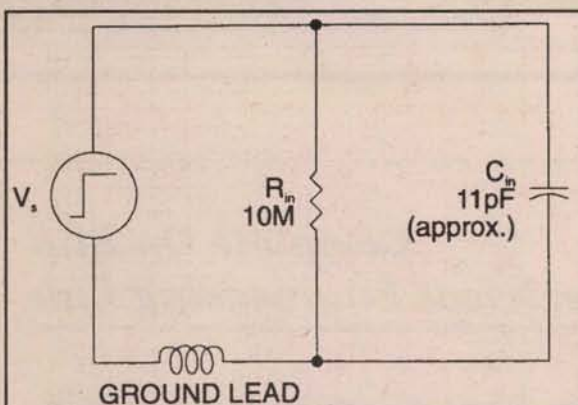


Figure 13. Equivalent circuit of a typical 10X probe and scope input.

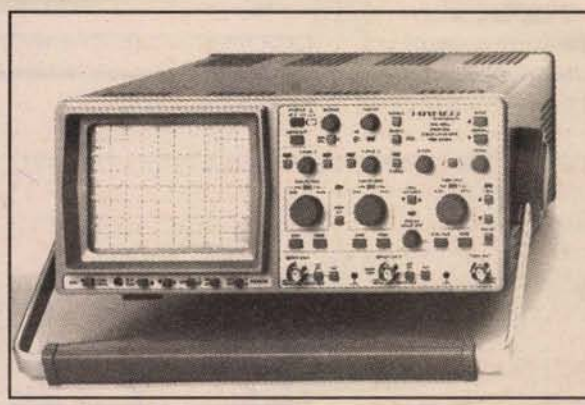


Figure 15. Hameg HM 1004 dual trace, dual time-base, microprocessor controlled oscilloscope.



Figure 14. Elenco S-1325 dual channel scope.

Probe Ground Lead Effects

As circuit frequencies increase — and risetimes get shorter — probe grounding becomes ever more important. An inadequate ground lead (one that is too long and/or has too much inductance) can adversely affect the fidelity of

high-frequency signals (see sidebar, "Probe Grounding"). To see why probe grounding is so important, start by looking at Figure 13 which shows the equivalent circuit of a typical 10X probe. Note that the ground lead L and input C form a series

resonant circuit with only 10 megohm of damping resistance. When hit with a fast pulse, this circuit will ring. With a six-inch ground lead, a typical probe will ring at about 150 MHz. Scopes with a bandwidth of 100 MHz or less will not be affected much by this. As scope bandwidths increase, however, this ring-

ing will become more noticeable. Because of this, you should always use the shortest possible ground connection possible.

ANALOG SCOPES

As previously mentioned,

the majority of scopes sold today are DSOs. This is partly due to economics — after reaching a certain performance level, it becomes more cost-effective to process the signal digitally. Even amongst the few analog scopes still being made, many use digital circuits for front panel controls, on-screen readouts, cursors, etc.

The one advantage which analog scopes still retain is the ability to display a signal in real time. As will be shown later, DSOs spend a great deal of time processing signals. At fast sweep rates, the scope will actually spend more time processing than sampling. For example, at 1 microsecond per division, a complete sweep may show 10 microseconds of the signal. An analog scope would rearm its trigger and be ready to display another sweep almost instantaneously. Under these conditions, such a scope might display up to

100,000 waveforms per second.

On the other hand, a DSO would take so much time to process each waveform that it would only show maybe 100 waveforms per second, or about 0.1% of the signal. If you're trying to catch a random glitch which occurs infrequently, these are not very good odds!

In choosing an analog scope, there are a variety of factors that will dramatically affect the usefulness — and usually, in direct proportion, the cost — of your instrument. Once you have determined the bandwidth necessary for your application, you will next need to decide how many channels (vertical circuits) and timebases (horizontal circuits) that you need.

Single channel, single time-base scopes have been obsolete for some time now. A simple dual channel scope such as the Elenco S-1325 (Figure 14) can provide basic scope functions for less than \$350.00.

Aside from showing two waveforms on the same screen, the dual channel scope makes it possible to measure precise timing relationships between two signals. This is often the number one reason for using an oscilloscope in the first place. Of course, if two channels are better than one, then four (or more!) channels would be even better yet. But dual channel scopes are usually sufficient, especially when an external trigger input can sometimes be used as a third channel.

While not as popular or useful as dual channels, a dual timebase is often handy when making measurements on more complicated waveforms. The second timebase acts like a "super horizontal magnifier" to expand out a section of the main waveform. For example, when analyzing video waveforms, the main timebase can be triggered at a field rate while the delayed timebase is used to view a single line of video at the faster horizontal line rate.

Most analog scopes offer AC/DC input coupling, variable magnification (both vertical and horizontal), and various triggering modes. Alternate, chopped, sum and difference, and X-Y vertical modes are standard offerings. More expensive scopes will include a TV sync trigger (for viewing video signals), variable holdoff (for viewing complex waveforms), and input delay lines (for viewing the leading edge of a triggered signal). Top of the line instruments such as the Hameg HM 1004 (Figure 15) add on-screen readouts, cursor measurements, and automatic set-up. Other specifications to examine are

triggering bandwidth, vertical and horizontal accuracy, and external interfaces. Next month, we will con-

tinue with a discussion of digital storage scopes and how to evaluate their specifications. We will also

touch upon some specialty scopes and how they can solve specific troubleshooting problems. We will

then conclude by examining portable and PC card-based instruments. **NV**

Probe Grounding

A passive probe is a capacitive divider for high-frequency components. Inductance introduced by a long signal or ground lead will form a series resonant circuit that will "ring" if driven by a signal containing significant frequency components at or above circuit resonance. These oscillations can appear on the oscilloscope display and distort the true waveform. Ground leads and probe tip connections should therefore be kept as short as possible to maintain the best fidelity.

The following figures show the results of using various length ground connections while observing a very fast pulse (70 ps risetime) on an oscilloscope with a 500 MHz bandwidth.

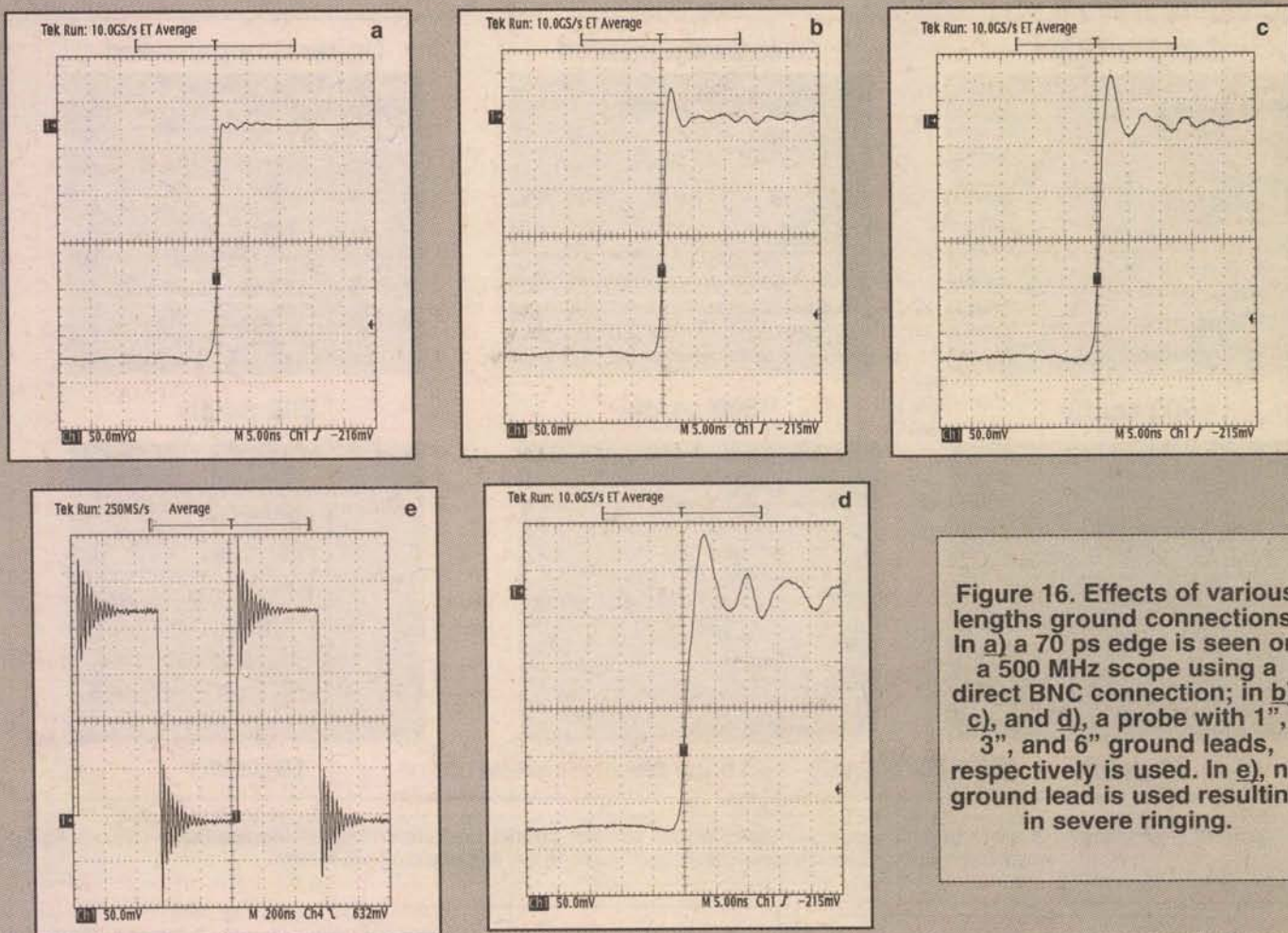


Figure 16. Effects of various lengths ground connections. In a) a 70 ps edge is seen on a 500 MHz scope using a direct BNC connection; in b), c), and d), a probe with 1", 3", and 6" ground leads, respectively is used. In e), no ground lead is used resulting in severe ringing.



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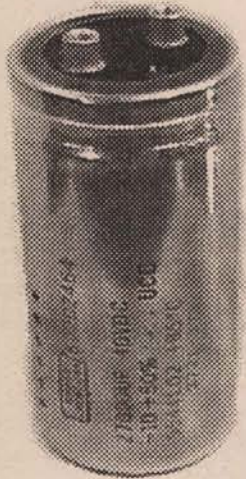


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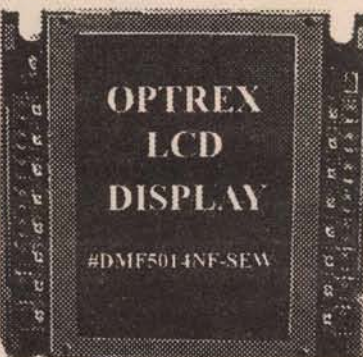


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PROGRAM DISKETTES contains list of all commands, a file that contains list of initialization steps, and a text file that has the 68hc11 program
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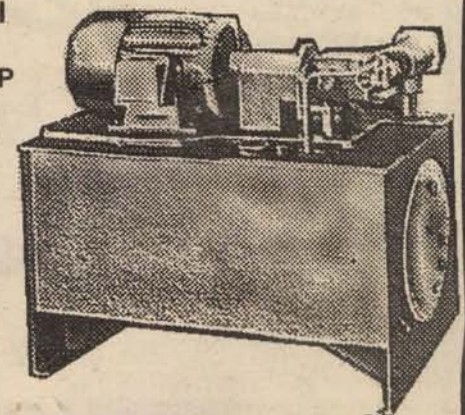
INSULATION COLOR	WIRE AWG	STUD SIZE
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Application: Hydraulics, gasoline, fuel & lubrication oils, air and water.

Operating Temp range: - 40°F to 212°F
Reusable female fittings on both ends.

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CROSS SECTION OF HYDRAULIC HOSE

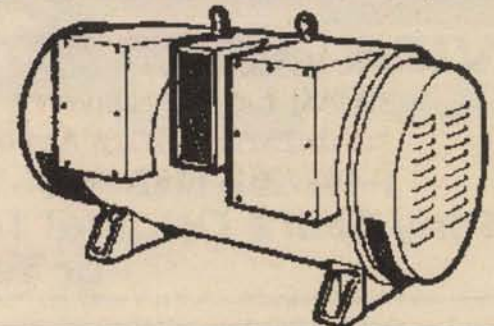


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THE SOLDERLESS BREADBOX

by Don Wilcher

Digital Indicators

In reading the Aug. '96 issue of *Sensors*, I came across an ad for Omega Engineering products. In this advertisement, one of the products caught my eye: Digital indicators. Digital indicators are rectangle boxes which have seven-segment displays for providing visual information such as process and electrical measurements.

Now some of you might have heard the words "digital panel meter" some years back. Well, digital indicators and panel meters are one and the same, folks!

In looking at the unit, digital indicators (DIs) are usually digital voltmeters with the ability to be converted into electronic thermometers, digital tachometers, and fuel gauges using input cards. The cost of these units range from \$150-\$200. The unit I have was removed from an old industrial control process panel.

In this month's column, we will explore digital indicators and see how they can be used in logic gate applications. So let's begin our discussion of digital indicators with the design and operation of these practical units.

Operation of Digital Indicators

In recent years, the digital readout of voltage and other electrical quantities has become an inexpensive alternative to the analog moving coil meter. The basic element of the digital indicator is the digital voltmeter (DVM). The DVM is a voltage actuated device with a numerical display of the measured quantity. Basic to all DVMs is the necessity for converting the analog voltage to be measured into an accurate digital representation. This is accomplished by an analog-to-digital converter (ADC).

ADCs are sometimes called a digitizer because it determines the number of units or increments that make up the measured voltage. Once the data is present in the digital domain, one of the several popular types of displays such as light emitting diodes (LED), light emitting diode displays, or liquid crystal displays (LCDs) are used to provide a visible, numerical indication to the user.

Accurate digital representation of an analog voltage can be accomplished by several methods. In DVMs, digitization is most often performed by converting the input voltage into a number of discrete increments of charge and counting the increments.

Dual Slope Conversion

In one popular digitization technique known as

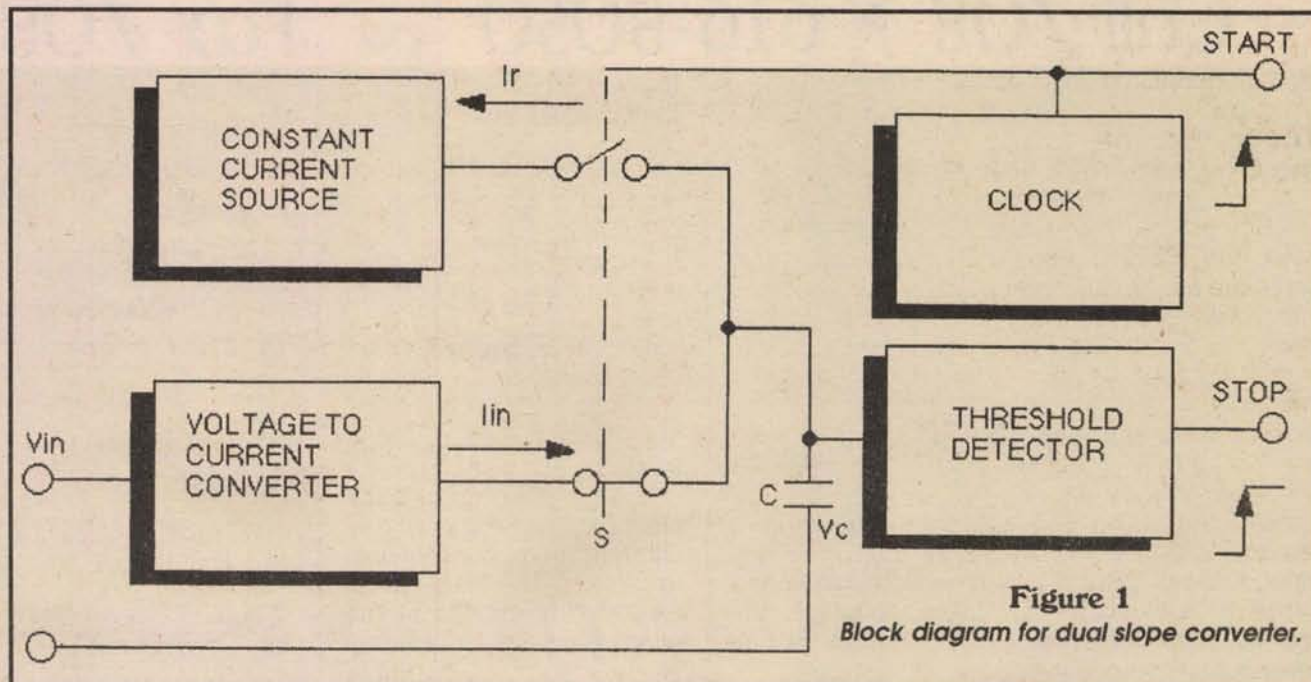


Figure 1
Block diagram for dual slope converter.

the dual slope converter, the input voltage "Vin" is converted to a proportional current that is used to charge a capacitor for a precise period of time.

Figure 1 shows a block diagram of the dual slope conversion process. A charge "q" proportional to Vin and time "tin" accumulates on the capacitor during "tin." Then, the clock disconnects switch "S" from the input source and connects a constant reference current "Iref" to discharge the capacitor and generate the start signal. When the threshold detector monitoring the capacitor voltage indicates that the capacitor has been discharged, a pulse occurs at the output labeled "Stop" and the cycle of charging the capacitor from the unknown source and discharging it from the reference source repeats. Since the amount of charge required to discharge the capacitor is equal to the charge stored, the

time "tr" required to discharge the reference current is also proportional to "q."

This relationship between "tr" and "q" can be expressed mathematically with the equation:

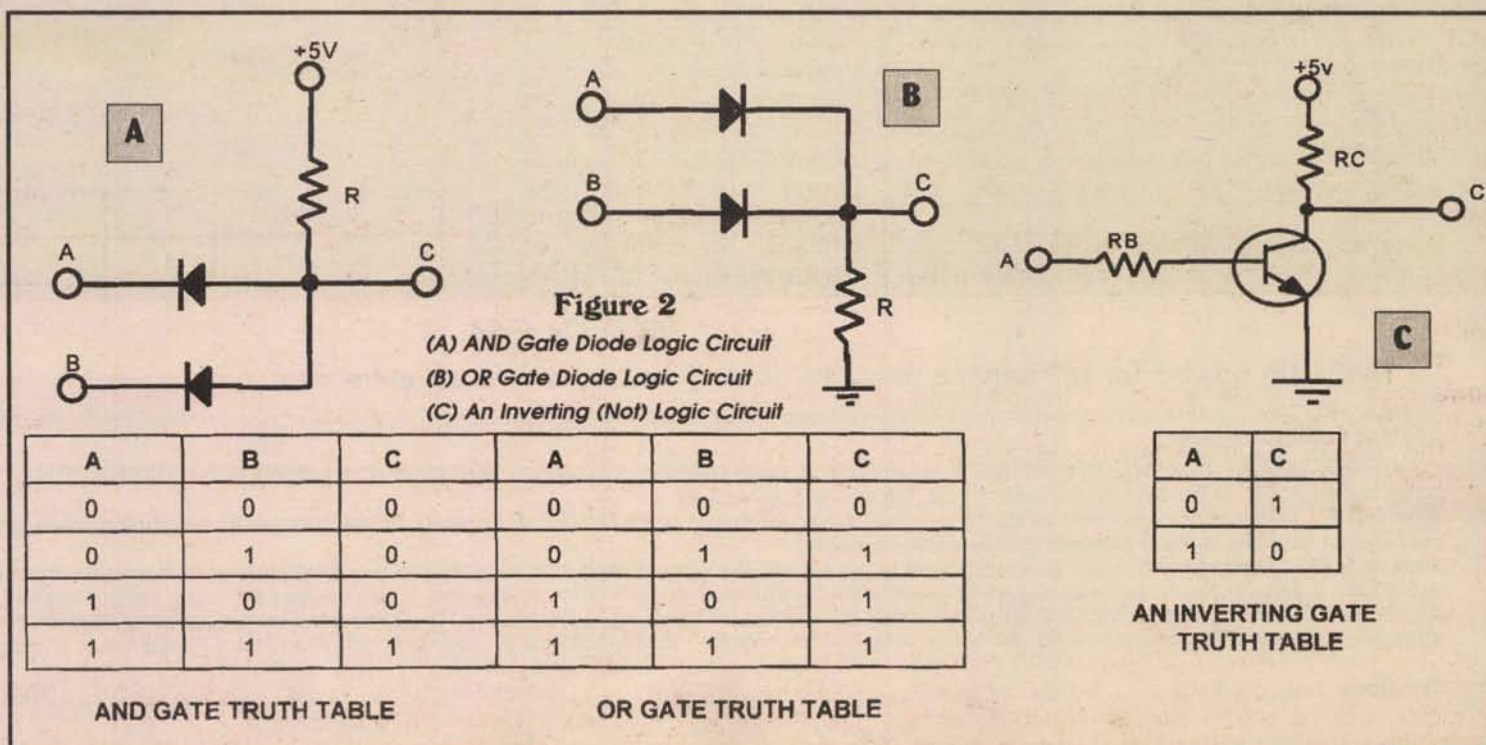
$$I_{ref} \times t_r = q = K \times V_{in} \times t_{in} \text{ or } t_r = V_{in} \times (K \times t_{in} / I_{ref})$$

where

"K" is the proportionality constant between "Iin" and "Vin."

"tr" is the time interval between the appearance of pulses at outputs "Start" and "Stop"

The dual slope converter thus produces a voltage-to-time interval interdomain conversion. The time interval "tr" can be measured by counting pulses from a standard clock oscillator. The pulses at "Start" open the counting gate and allow clock pulses through to the counter. The



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pulse at "Stop" disconnects the clock from the counter. When the counting has ceased, the digital output from the counter is presented to the display.

In practice, the various proportionality factors between the number displayed and the input voltage are arranged so that the display reads directly in volts.

Now that the fundamentals of digital voltmeters/indicators have been discussed, let's see how they can be used to convey information on the operation of logic gates.

Theory Behind the Operation of Logic Gates

Computers and electronic instrumentation have one thing in common: logic gates. Logic gates are the fundamental building blocks behind integrated circuits (ICs) and microprocessor chips. By combining these basic circuits, more complex chips, devices, and systems can be created.

The basic logic gates used in digital systems are the "AND," "OR," and "NOT" circuits. As shown in Figure 2A, the "AND" gate can be constructed using two silicon diodes and a resistor. With a LO or 0V signal applied to any input, this will forward bias the silicon diode and cause the output to be LO. Only when both inputs are HI (approximately +5V) are both diodes reversed biased and the output HI.

The "OR" gate shown in Figure 2B operates opposite to the "AND" gate. When one input is HI, the corresponding diode is forward biased and the HI input (+5V) level is transmitted to the output. Only when all inputs are LO are all diodes reversed biased and a LO output obtained.

For both the AND and OR circuits, additional diodes could be added to accommodate more input signals.

If you are only interested in changing states of one input, then the INVERTING or NOT circuit can be used in this application.

Figure 2C shows the circuit for the INVERTING logic gate. The operation of this transistor inverter circuit works where a HI signal at the input turns the transistor on, producing a LO (approximately 0.2V) output signal. However, for a LO signal at the input (<0.6V), the transistor is off and the output level is HI. To create the inverted state of these basic logic gates requires adding a NOT or INVERTER to the output of the smaller circuits.

Figure 3 shows a simplistic approach to the design of logic ICs. In this circuit, we see the logic function and the output buffer amplifier combined into a single circuit in an integrated circuit logic gate.

There are several different types of IC logic gate families. The most popular ICs used are the 7400/74LS00 TTL (Transistor-Transistor Logic) series.

TTL gates use +5V power supplies and their power dissipation limits can sometimes be taxing on batteries if used.

The CMOS (Complementary Metal-Oxide Semiconductor) chips eliminate the TTL problems and provide a more user friendly and flexible voltage range (+4.18-+18V) for the circuits CMOS chips that are designated as the "4000" series and can be direct substitutes of its rebellious cousin the TTL.

But for the CMOS/TTL ICs, each family's logic and amplifier circuits are different. The buffer amplifier is designed so that its output signal is within the appropriate HI and LO ranges for its

logic type, and is capable of driving the inputs of a number of other gates of the same type.

In the paragraphs to follow, sample logic circuits will be explored with the help of the DI to reveal the inner workings of these fascinating gates.

Power Inverter Logic Circuit

The circuit shown in Figure 4 is an inverter logic circuit that has one special feature. This logic gate is capable of driving incandescent bulbs and motors directly. The TIP31 power transistor can handle electrical loads up to 3 amps and have a voltage range from 3 to 40 volts.

As seen in Figure 4, the pinout for this chip is slightly different from conventional transistors. The "base" pin is on the side instead of the middle and pin 4 is located on the mounting tab and is designated as the collector terminal.

Usually with power devices, an external heatsink would be required to keep the component cool. But in the case of logic circuits and driving a small "3V" DC motor, a heatsink is not required.

The voltage measured at the collector circuit is 2.110V at logic 0 and 0.11V with the switch closed (logic 1). This voltage can be monitored using you guessed it — a digital indicator.

The digital indicator used in this project was a Radio Shack DMM w/PC Interface (Cat No. 22-168). The reason for using this tester is because of the LO/HI function for monitoring logic circuits. As shown in Figure 4B, the DMM/DI is capable of displaying HI and LO status of the circuit under test. This DI feature makes the logic measurement more meaningful.

In addition to displaying logic, in the upper right hand corner of the DMM, the measured DC voltage is displayed. Talk about convenience!

The power supply circuit for motor control operation is set to 5V. Depending on the motor being used, the device may have to be kick-started via turning the shaft of the motor. The maximum voltage that can be supplied to this circuit is 5.5V. This will alleviate having to start the motor via hand rotation of the shaft.

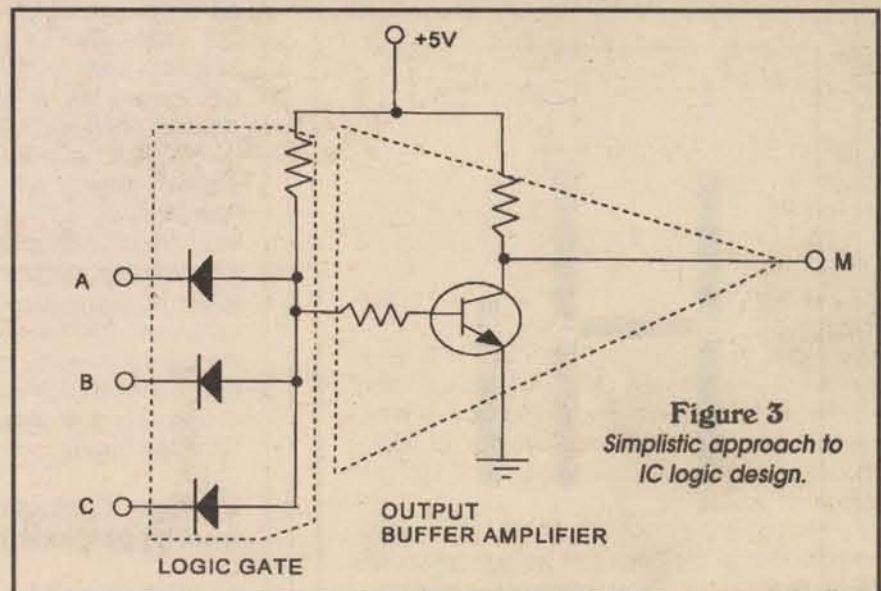


Figure 3
Simplistic approach to IC logic design.

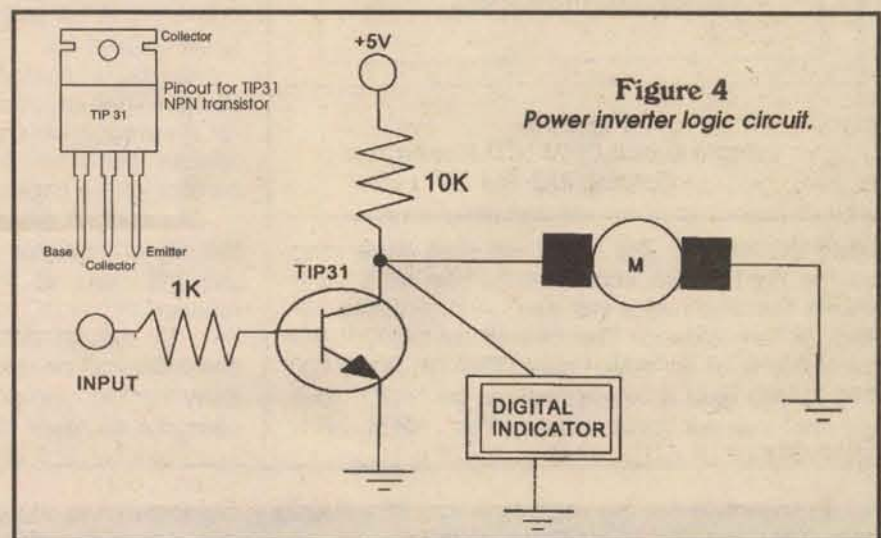


Figure 4
Power inverter logic circuit.

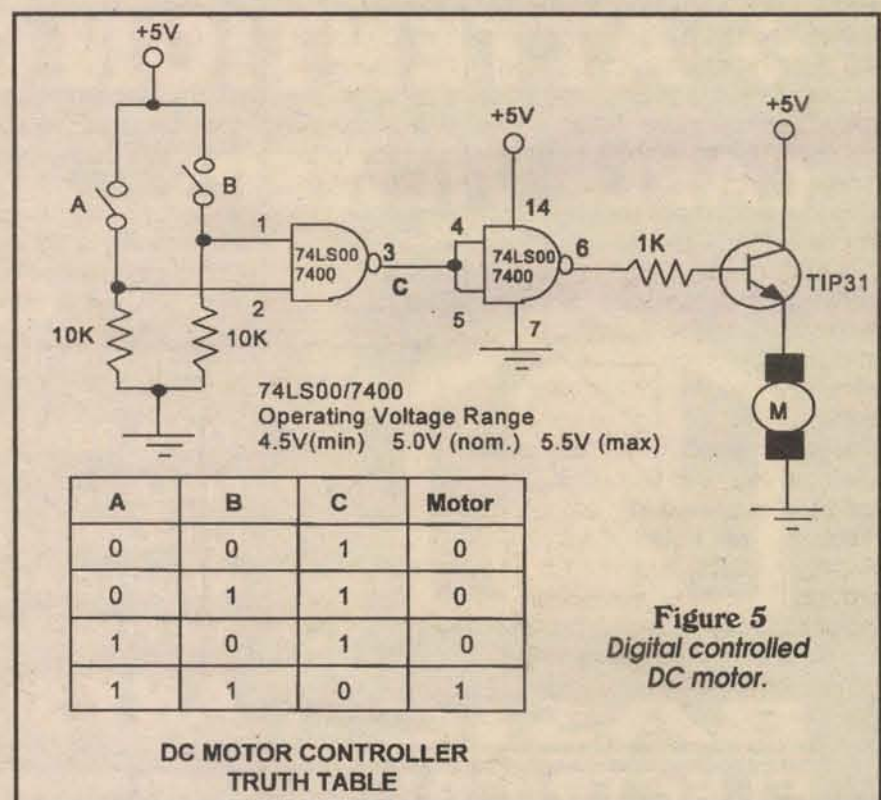


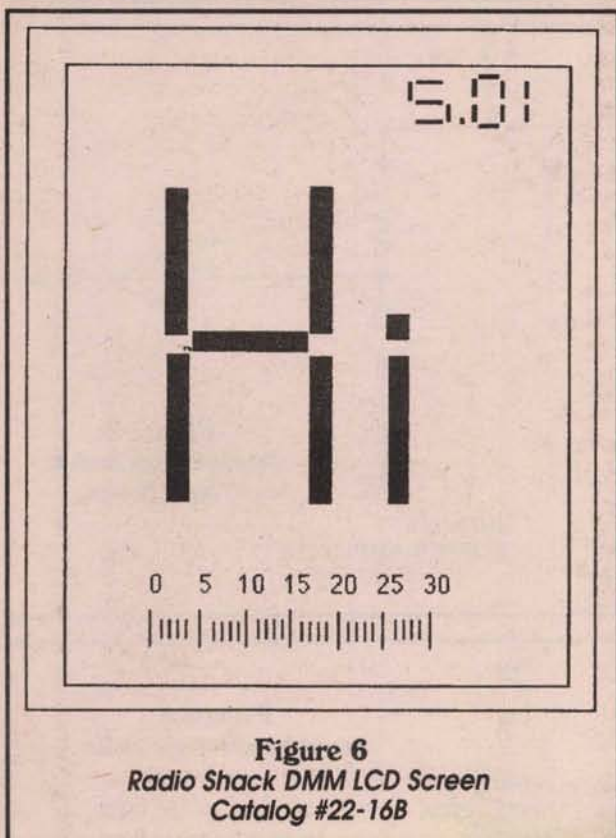
Figure 5
Digital controlled DC motor.

This basic circuit can be used to drive lamps and motors while being controlled digitally with a simple logic gate. The circuit in the following paragraph will illustrate this digital control concept.

A Digital Controlled DC Motor

The circuit in Figure 5 is a digital controller for

THE SOLDERLESS BREADBOX



small DC motors. The motor will start depending on the right switch combination. The truth table shows that the motor will turn on if switches "A" and "B" are closed. The overall function of the controller is of an "AND" gate. The 74LS00/7400 TTL NAND gate is converted into an "AND" gate via the inverter logic circuit. The TIP31 NPN

power transistor will have enough gain to drive the DC motor. The DI used for circuit measurements is Radio Shack DMM w/PC interface. This unit is configured as a digital logic probe where a reading of HI and LO will be displayed on its LCD.

In addition to this logic display, the associated analog voltage will be shown in the upper right hand corner of the screen as well. The controller will activate the motor if input switches "A" and "B" are high. As mentioned earlier, the truth table is a logic window into the operation of the motor controller. This analysis tool will show what state the inputs need to be in, in order for the motor to turn on. An LED can be added at point "C" for monitoring the logic state of the input switch interface circuit.

Further Thoughts and Experimentation

Well folks, I hope the mystery behind digital indicators (DIs) and digital voltmeters (DVM) has been cleared up.

Digital indicators are interesting measuring devices that can be used as electronic windows for viewing a circuit or system's operation. The circuits discussed in this column scratched the surface of the capability of these digital units.

As seen in the digital motor controller circuit, the digital indicator provided an electronic eye into the state of the input switches and the reaction of the DC motor to these logic values.

By adding data logging capabilities, this controller can be used as an electromechanical relay or DC motor tester. By cycling these components, data can be logged via the digital

indicator. The data collected by the unit could then be plotted and analyzed.

To modify this circuit for that function, you would need to connect the digital indicator (Radio Shack DMM w/PC interface) across the relay or motor coil and use the DMM as a data logger/indicator, recording the switching motor or relay coils voltage via the PC interface of the meter.

Using a spreadsheet package such as Lotus or Excel, create a characteristic curve for this experimental set-up. This project will make an excellent science project for school science fairs because of its data logging capabilities for collecting empirical values that can be plotted automatically via the "Windows"-based software. The data can later be analyzed and summarized into a lab report.

In testing automotive components, an engineering specification is created by the engineer. This document includes a procedural method for testing the component similar to what was described here. So you now have a method for characterizing electromechanical components using this simple/innovative data logging system and the lonely, but hard-working digital indicator. NV

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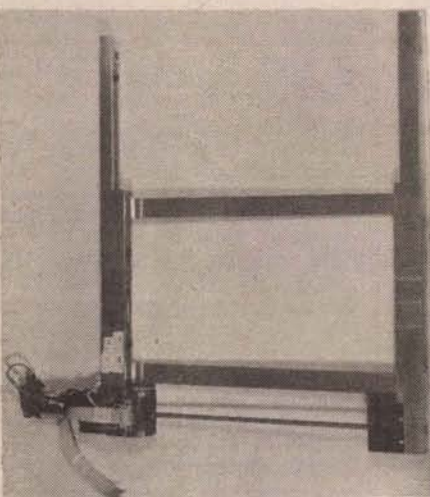
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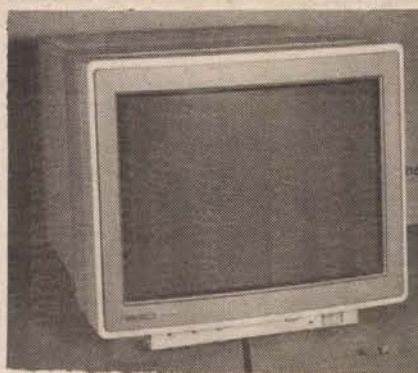
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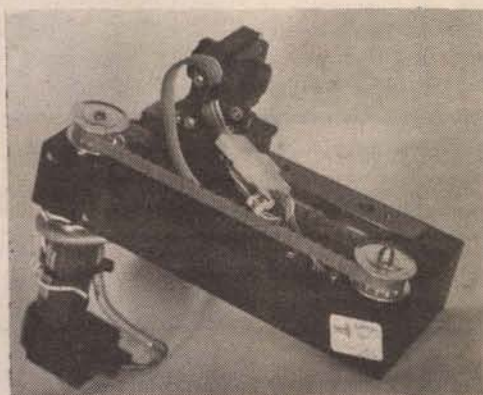
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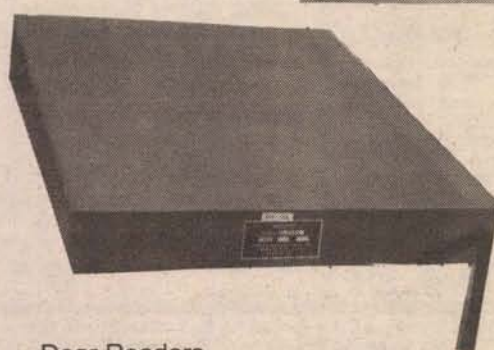
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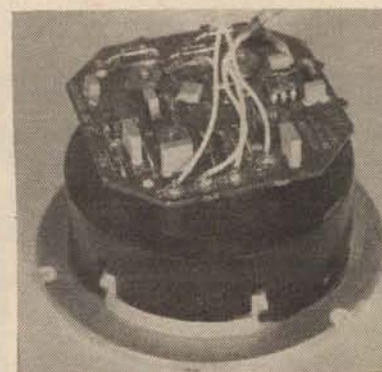
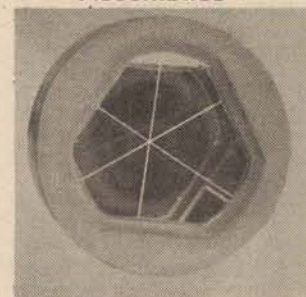
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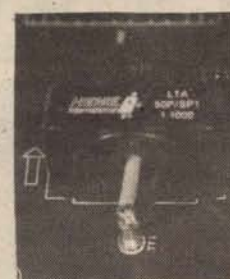
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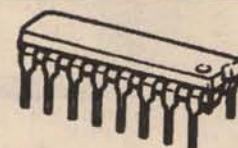
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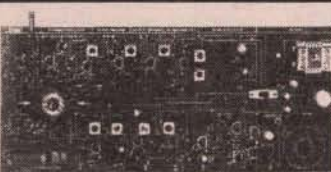
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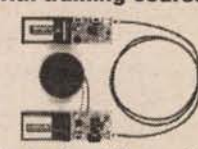
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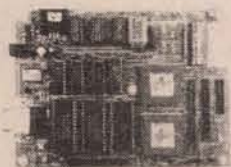
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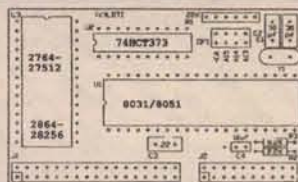
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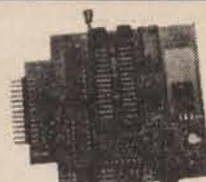
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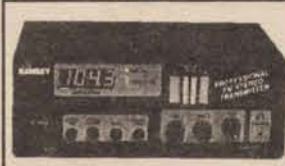
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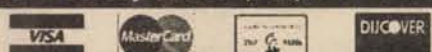
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More on Sensors

Open Channel

by Joseph J. Carr
K4IPV

The response to my sensor resolution improvement method columns was most encouraging. I heard from several people who wanted to use it for optical sensing. One of them was a guy who designs image densitometers for some industrial purpose.

I recall various types of densitometers from the years when I worked in medical electronics at a large eastern university medical center. Those densitometers were used to "read" exposed x-ray badges. The little badges worn by x-ray technicians, radiologists, and others were read by a radiation physicist using a white light densitometer. The badges consisted of a small strip of photographic film that would be fogged when exposed to x-rays. He explained to me that the ratio of the light transmittal through unexposed film to that through exposed film could be converted to radiation exposure.

If the technician received too much radiation in any month, then he or she would be reassigned to other duties for a period of time ... if he/she was lucky. Some hospitals simply laid off the technician for the required period of time — unpaid, of course.

Sadly, x-ray technicians don't count for much in a hospital's pecking order, even though most of the docs and nurses could not do their work without them. But I did see one x-ray technician pull off a good one. A large, muscular thoracic surgeon (the kind of doc that does open heart operations) apparently thought that he was God's gift to mankind, and had an attitude to match. The x-ray technician was a small petite young lady who was barely out of her teen years. She was also something of a mouse on the outside, but apparently concealed a tiger on the inside.

One day, Doctor BigShot got on the elevator with his lit cigar (despite the city law against smoking in a hospital!), and blew

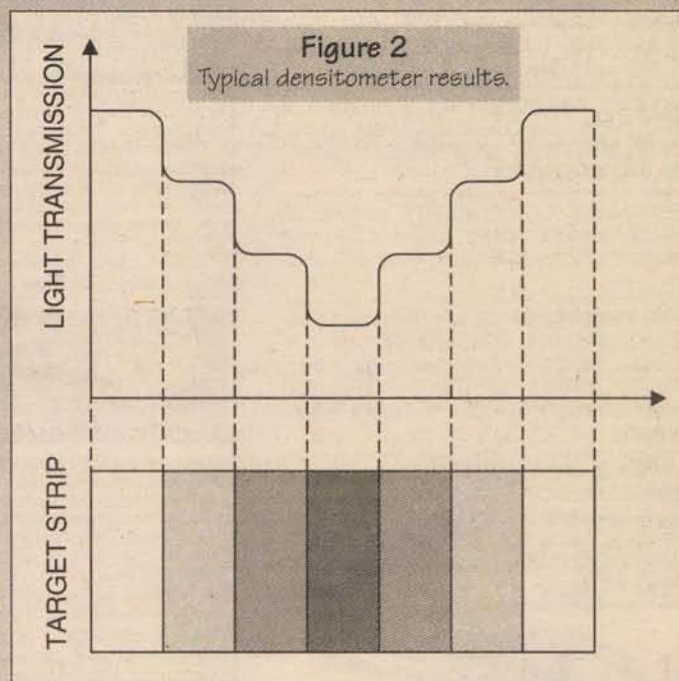
smoke in everyone's eyes. The sneer on his face suggested that mentioning the cigar would be fatal. Famous for his evil temper when crossed, Doctor BigShot was as arrogant as they came. Miss Mouse reached up, took the cigar out of his dribbling mouth, and crushed it on the floor. Turning back towards the front of the elevator, she said "you ought to be ashamed of yourself!" A dozen silent cheers went out of that elevator along with an angry, but too-flustered-to-respond Doc BS.

Enough digression. Another use of densitometers is in photographic darkrooms. These instruments give the lab technician some idea of the density of the negative, thus allowing the machinery used to print the pictures to be adjusted correctly. Still another use I have seen is in a modified form used to read microscope slides of some icky stuff or another.

Figure 1 shows the basic scheme for a densitometer. It consists of a light sensor and light source aimed at each other across a path where the sample can pass. Note that it is simply enough to allow you to experiment if you want to. In the case shown in Figure 1, the "target" is an exposed film strip. The particular case shown has the film exposed in steps going from unexposed at the ends, and then strips of progressively more exposure. The exposure gets deeper towards the center of the film strip, and then reverts to the less deep on the other end of the strip.

Figure 2 shows a top view of the film, along with the output of the light sensor. As the film passes under the sensor, it first encounters the unexposed white regions, so the output of the sensor indicates a lot of light passing through the film. At the next step, a small exposure drops the light a certain amount, followed by still more drop as the film progresses towards the center. At the other end of the strip, the process reverses itself.

The output signal from the densitometer can easily be digitized and fed to a computer for processing. The sensor output is usually analog, while the computer likes to see



"base-2" numbers in the form of binary words four, eight, sixteen, twenty-four, or thirty-two bits long. If the sensor output is a voltage or current, then an analog-to-digital (A/D) converter can be used to make the conversion. Some optical sensors have the conversion built in, so produce a binary output to begin with — others have to make the conversion externally.

Figure 3 shows a scheme for calibrating the densitometer or doing quality control. My physicist friend had a calibration cell that he could use to expose film to test the system and make a rough calibration. It was set in a lead shielding to attenuate radiation from any direction other than the opening (which had a plastic cover over it to keep stuff from getting in). The film was placed on the bottom of the lead cell, and then covered except for one end with a stepped aluminum block.

By measuring the density of the exposed and developed film, and knowing the thickness of the various aluminum steps, and the exposure time, a certified bright guy or gal could figure out how much energy was impinging the film. I recall that the actual test block had about two dozen steps and was up to several centimeters thick at the widest end.

More on the Sensor Resolution Improvement Method

The Sensor Resolution Improvement Method (SRIM) was discussed in this column twice in the past several months. In that method, a pair of sensors is used rather than just one. The sensors are set up to measure the same objects passing in front of them, but are displaced from each other by a distance

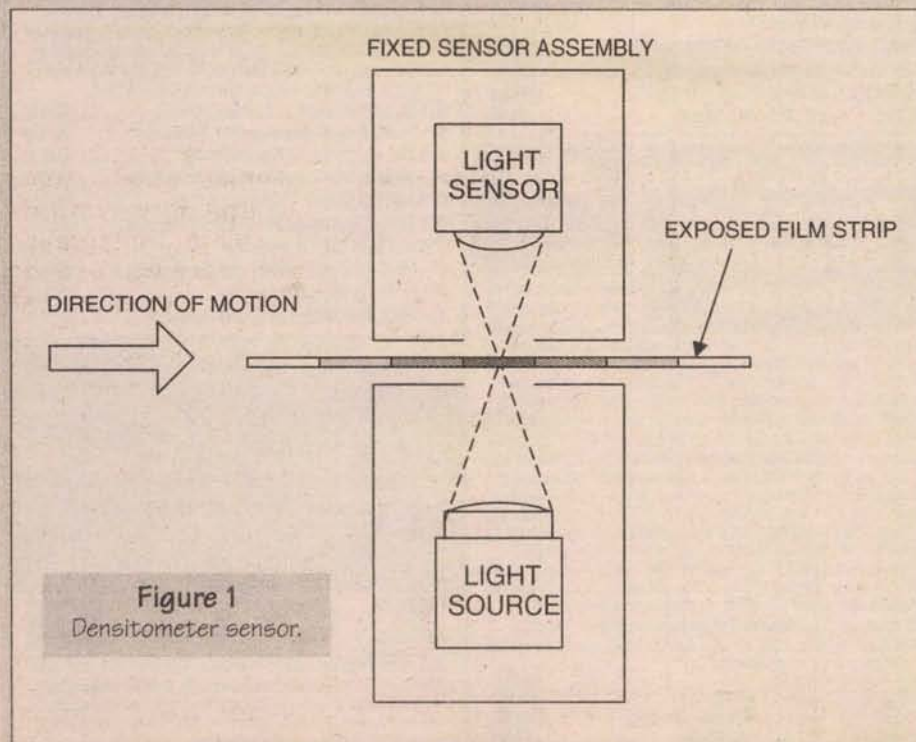


Figure 1
Densitometer sensor.

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ΔX . By taking their sum and difference, we can make a startling improvement in the apparent resolution of the system of sensors. It is a case of two acting as one being better than one alone. The ratio of the sum over the absolute value of the difference produces the improved resolution:

$$V_o = \frac{V1 + V2}{ABS(V1 - V2)}$$

There is a potential problem with using this equation in computer implementation. A reader pointed out that the denominator can go to zero, which means that the peak tries to go to infinity. In my spreadsheet models, the data skipped over the critical point, so it didn't show up. Also, in the analog circuit version, the peak hit the positive power supply rail, so was self-limiting. It would do so, regardless of the denominator, because of the immense height of the spike. However, in a computer, a "Divide-by-Zero Error" would be generated. But there is a simple cure, also provided by the reader.

Consider Table 1. This data is synthetic and is derived from a symmetrical graph hand drawn on old-fashioned graph paper. The heights ("amplitudes") were measured or guesstimated at a number of points along the horizontal axis, and the results entered into an Excell spread-sheet. The "A" and "B"

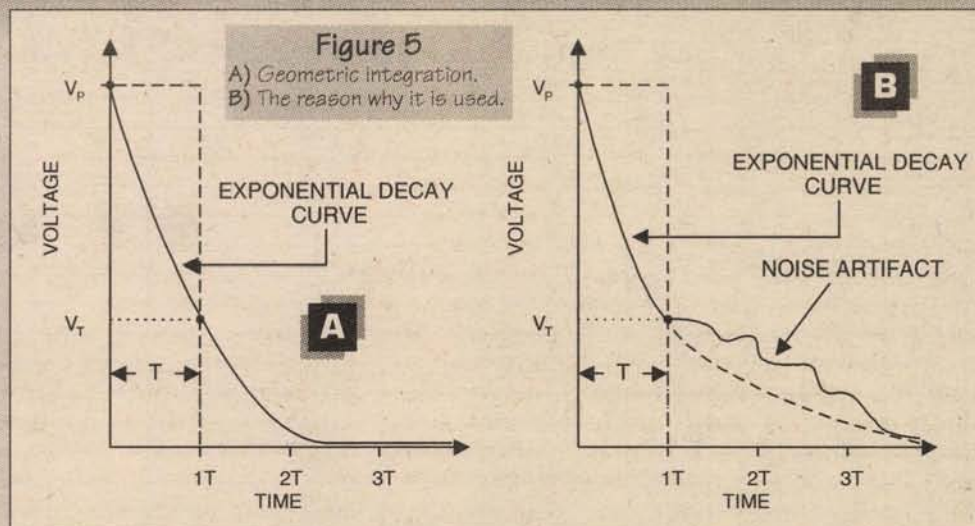
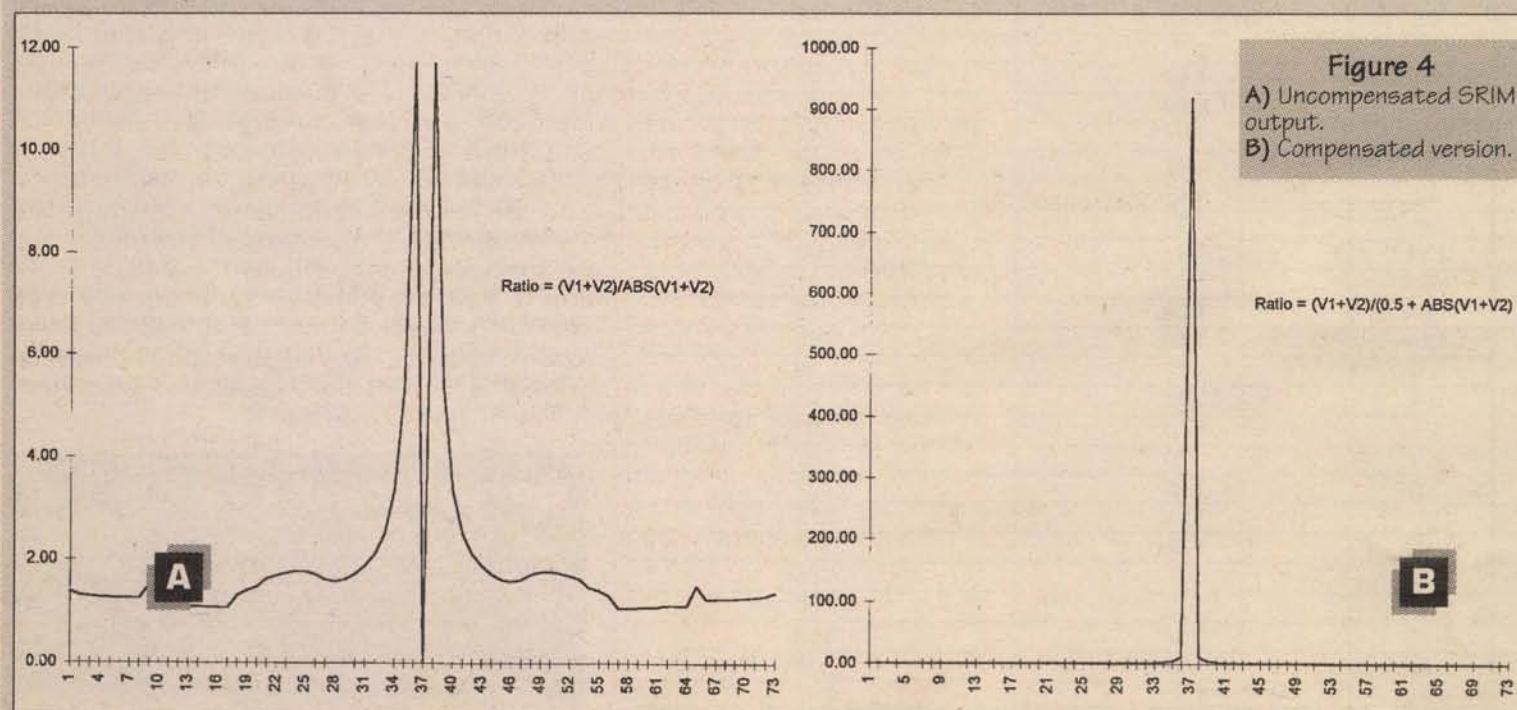
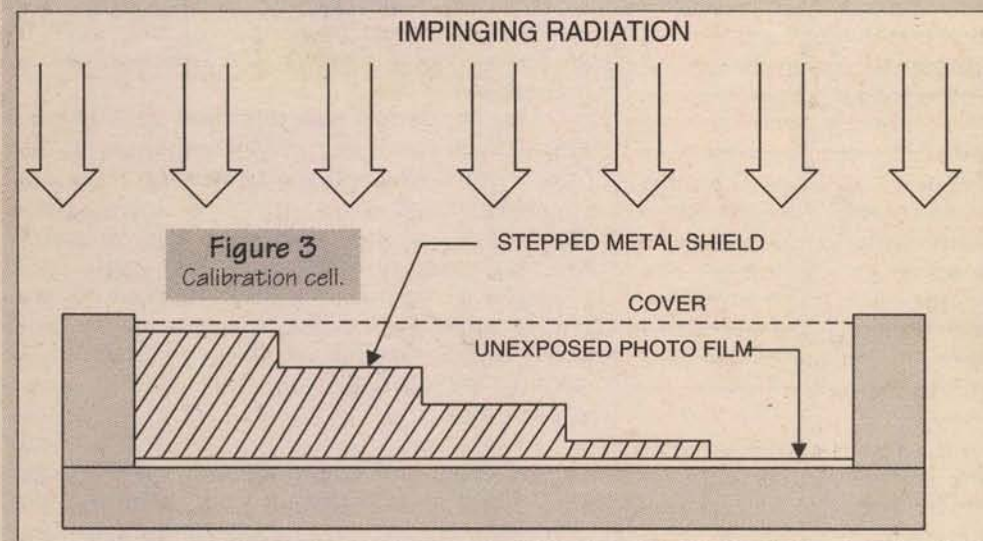
columns represent "V1" and "V2," respectively. Additional columns to the right of A and B calculated the sum, difference, absolute value of the difference, and the ratio described by Equation 1 above.

The result is the graph shown in Figure 4A. Note that the center takes a sharp dip to zero-zip-nothing at 37 mm. The problem was that the spreadsheet calculations didn't like zero in the denominator, so generated a "#DIV/0!" error in the maximum value cell. The graphing function of Excell took that to be a zero cell, so treated it as such.

The reader who sent me an E-Mail suggested something on the order of Equation 2.

$$V_o = \frac{V1 + V2}{0.5 + ABS(V1 - V2)}$$

By adding 0.5 to the $ABS(V1 - V2)$ term in the denominator, we limit the maximum excursion of the peak amplitude. Figure 4B shows the same data graphed according to the rule of Equation 2. Note that it produces a peak value of 920, rather than trying to reach infinity. If you



use SRIM on a computer-based project, then you might want to try using some version of Equation 2 with an offset constant suitable to your needs (I used 0.5 because the reader suggested it).

BASIC-Stamp or PicStic-3 Implementation Anyone?

Being an unabashed fan of Scott Edwards' column on BASIC Stamps in *Nuts & Volts*, I am experimenting with those neat little tools myself. I bought a BSC-2, a Counterfeit, and the analog board from Scott Edwards Electronics (see Scott's column for the address). It seems to me that a BASIC Stamp with a two-channel A/D converter on the front-end could provide the data to a larger computer, and possibly do the arithmetic itself. If nothing else, it could log the data and upload it to a PC via the serial communications port.

Another possibility, and one that appeals to me even more, is to use the Micromint, Inc. (4 Park Street, Vernon, CT 06066-3233) PicStic-3 device. It is similar to a BS-1, but has two extra I/O bits (10 rather than 8) and a two-channel A/D converter (not to mention being a tad cheaper). Except for the A/D function, the PicStic-3 will work on PBasic programs.

Geometric Integration Revisited

Last month, we took a look at various methods of integrating an analog waveform. Recall that integrating the varying analog signal finds the area under the V-vs-T curve, and will produce an output proportional to the time-average of the signal. This measurement is often more useful than the actual data collected. One of the methods discussed was geometric integration, which is used to integrate exponentially decaying curves. Those curves the-

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A	B	A+B	A-B	ABS(A-B)	Ratio = (V1+V2)/ABS(V1+V2)	Ratio = (V1+V2)/(0.5+ABS(V1+V2))
0.032	0.2	0.232	-0.168	0.168	1.38	0.35
0.04	0.3	0.34	-0.26	0.26	1.31	0.45
0.05	0.4	0.45	-0.35	0.35	1.29	0.53
0.06	0.5	0.56	-0.44	0.44	1.27	0.60
0.07	0.6	0.67	-0.53	0.53	1.26	0.65
0.08	0.7	0.78	-0.62	0.62	1.26	0.70
0.09	0.8	0.89	-0.71	0.71	1.25	0.74
0.1	0.9	1	-0.8	0.8	1.25	0.77
0.2	1	1.2	-0.8	0.8	1.50	0.92
0.3	5	5.3	-4.7	4.7	1.13	1.02
0.4	7	7.4	-6.6	6.6	1.12	1.04
0.5	9	9.5	-8.5	8.5	1.12	1.06
0.6	13	13.6	-12.4	12.4	1.10	1.05
0.7	17	17.7	-16.3	16.3	1.09	1.05
0.8	21	21.8	-20.2	20.2	1.08	1.05
0.9	26	26.9	-25.1	25.1	1.07	1.05
1	31	32	-30	30	1.07	1.05
5	37	42	-32	32	1.31	1.29
7	41	48	-34	34	1.41	1.39
9	47	56	-38	38	1.47	1.45
13	54	67	-41	41	1.63	1.61
17	66	83	-49	49	1.69	1.68
21	78	99	-57	57	1.74	1.72
26	93	119	-67	67	1.78	1.76
31	112	143	-81	81	1.77	1.75
37	141	178	-104	104	1.71	1.70
41	175	216	-134	134	1.61	1.61
47	209	256	-162	162	1.58	1.58
54	230	284	-176	176	1.61	1.61
66	248	314	-182	182	1.73	1.72
78	255	333	-177	177	1.88	1.88
93	260	353	-167	167	2.11	2.11
112	263	375	-151	151	2.48	2.48
141	260	401	-119	119	3.37	3.36
175	255	430	-80	80	5.38	5.34
209	248	457	-39	39	11.72	11.57
230	230	460	0	0	#DIV/0!	920.00
248	209	457	39	39	11.72	11.57
255	175	430	80	80	5.38	5.34
260	141	401	119	119	3.37	3.36
263	112	375	151	151	2.48	2.48
260	93	353	167	167	2.11	2.11
255	78	333	177	177	1.88	1.88
248	66	314	182	182	1.73	1.72
230	54	284	176	176	1.61	1.61
209	47	256	162	162	1.58	1.58
175	41	216	134	134	1.61	1.61
141	37	178	104	104	1.71	1.70
112	31	143	81	81	1.77	1.75
93	26	119	67	67	1.78	1.76
78	21	99	57	57	1.74	1.72
66	17	83	49	49	1.69	1.68
54	13	67	41	41	1.63	1.61
47	9	56	38	38	1.47	1.45
41	7	48	34	34	1.41	1.39
37	5	42	32	32	1.31	1.29
31	1	32	30	30	1.07	1.05
26	0.9	26.9	25.1	25.1	1.07	1.05
21	0.8	21.8	20.2	20.2	1.08	1.05
17	0.7	17.7	16.3	16.3	1.09	1.05
13	0.6	13.6	12.4	12.4	1.10	1.05
9	0.5	9.5	8.5	8.5	1.12	1.06
7	0.4	7.4	6.6	6.6	1.12	1.04
5	0.3	5.3	4.7	4.7	1.13	1.02
1	0.2	1.2	0.8	0.8	1.50	0.92
0.9	0.1	1	0.8	0.8	1.25	0.77
0.8	0.09	0.89	0.71	0.71	1.25	0.74
0.7	0.08	0.78	0.62	0.62	1.26	0.70
0.6	0.07	0.67	0.53	0.53	1.26	0.65
0.5	0.06	0.56	0.44	0.44	1.27	0.60
0.4	0.05	0.45	0.35	0.35	1.29	0.53
0.3	0.04	0.34	0.26	0.26	1.31	0.45
0.2	0.032	0.232	0.168	0.168	1.38	0.35

Table 1
Data for calculations

oretically go asymptotic to, but never reach zero. In other words, it has an infinite area under the curve.

The time constant (T) of an exponential decay curve is the time required for the voltage value to fall to e^{-1} times the peak value, or approximately $0.368E_p$ (see Figure 5A). In geometric integration reported last month, the integral is approximated by the area of a rectangle with one side equal to E_p , and the other equal to $1T$ (see Figure 5A).

One colleague, not a reader, but a close friend, uttered a big "so what ... why not just integrate to the practical end of the curve and guesstimate the rest." The "practical end" of the curve is at a five time constant, or $5T$. The area under the curve could be eyeballed on a graph.

Similarly, the integral could be guesstimated electronically by using a voltage comparator to find a voltage at or close to zero that one guesses is close to the voltage that would exist after $5T$.

Or, one could measure the exponentially decaying voltage using an A/D converter, and then use software to look for the point where the voltage drops to $0.368E_p$, and measure the time. One could then step out to $5T$ and measure the voltage at that point. From there, a complete curve is defined and integration can stop.

Or can it? My colleague was not considering the main use for this type of algorithm: noisy signals. Let's take a look at this aspect of the problem.

The first time I saw this method was on a dye dilution method cardiac output computer. The physician would squirt an indigo dye into the blood stream on the input side ("proximal") of the heart, and then measure the dye density change on the other side ("distal") of the heart with an optical sensor. By integrating the dye dilution curve, and doing a bit of arithmetic, the computer could display the cardiac output in liters of blood per minute.

In the dye dilution cardiac output computers used in the 1970s, some of the dye would recirculate, especially through the coronary arteries, and would produce a noise artifact in the exponential decay portion of the curve (Figure 5B). The actual trajectory of the exponential decay curve is obscured because of the noise. If the noise artifact occurs after the 0.368 (i.e., one time-constant) point, then geometric integration can be used to approximate the area under the curve.

The dye dilution method of cardiac output measurement gave way to thermal dilution about 20 years ago, but there are other areas where a noise artifact may occur, including situations where the exponential decay curve drops very rapidly into the noise level, or where external interference can cause artifacts at lower levels. **NV**

Connections ...

I can be reached in either of two ways:

1) by snail mail at P.O. Box 1099, Falls Church, VA 22041, or **2)** via Internet E-Mail at carrjj@aol.com — I appreciate your comments, suggestions, and criticisms.

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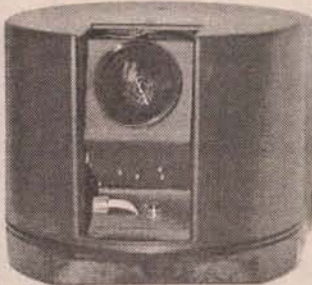
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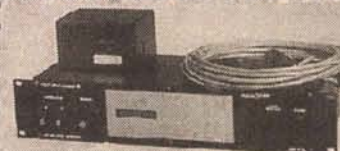
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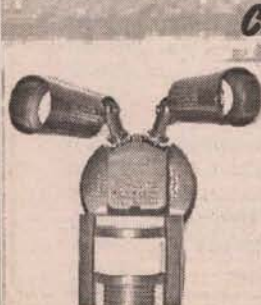
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Batteries are often used for electric power in many electronic projects and robotics. Batteries are so common place that it's easy to take them for granted. If a battery-powered project draws a substantial current or must be operated for long periods of time, replacing batteries can become expensive. In these cases, rechargeable batteries can provide substantial savings over standard batteries.

This month, we will design and build a NiCad battery charger. The charger may be easily modified to be compatible for a large variety of "battery packs" with different voltages and charging currents.

by
John
Irvine

Before we begin the charger project, let us first review some basic information on batteries. Understanding batteries will help you decide which batteries are suitable for a particular project.

Since there are hundreds of different batteries, we will only look at the most common batteries employed for hobbyist use: carbon-zinc, alkaline, nickel-cadmium, lead-acid, and lithium.

Battery Power

Regardless of battery type, battery power is measured in amp-hours; that is the current (measured in amps or milliamps) multiplied by the time (hours) that current is flowing from the battery. What does that mean to us? Well it's pretty straightforward. Suppose a battery is rated at two amp hours. This means the battery can supply two amps of current for one hour. If the current draw from the battery is only one amp, the battery will last two hours. If the current is further reduced to 500 mA, the battery will last four hours.

Your mileage may vary. Batteries provide more access to their electrical power when used intermittently. Allowing time for the battery to recuperate. Continuous duty is efficient if the load is light.

Battery Voltage

Battery voltage varies through the life of a battery. If you measure the voltage on a fresh "D"-sized 1.5-volts alkaline battery, it will read approximately 1.65 volts. As the battery discharges, its voltage drops. The battery is considered dead when the voltage drops around 1.0 volts. Typical discharge curves for carbon-zinc, alkaline, and Nicad batteries are illustrated in Figure 1.

Notice that a fresh Nicad 1.5-volt battery actually delivers about 1.35 volts. While its initial voltage is lower, its discharge curve is fairly flat when compared to carbon-zinc and alkaline. NiCads deliver a constant 1.2 volts.

Primary Batteries

Primary batteries are one-time use batteries. The batteries we will look at in this class deliver 1.5 volts per cell. They are designed to deliver their rated electrical capacity and then be discarded. Discarding depleted primary batteries can become expensive. Especially if the electrical system is to be used often. One advantage to using primary batteries is that they typically have a greater electrical capacity than rechargeables. If one is engaged in a function that requires the highest power density available for one shot use, primary batteries may be the way to go.

Secondary Batteries

Secondary batteries are rechargeable. The most common rechargeable batteries are Nickel-Cadmium (NiCads) and lead-acid. We will start with NiCads. One disadvantage to NiCad batteries are a lower voltage 1.2 volts per cell. So a "C" cell battery will deliver about 1.2 volts instead of 1.5 volts. The effect becomes more pronounced when using multiple cells. For

instance, a "nine-volt" NiCad battery will deliver approximately 7.2 volts.

Automotive lead-acid batteries are rechargeable, but are not really suitable for many uses. The reason being is that they are not designed to be completely discharged before recharging.

Complete discharge before recharging is called "deep cycle." Because of the solar power industry, there are "deep cycle" lead-acid batteries available. You will find these batteries carry a higher price tag over automotive batteries. When designing electrical supply systems, you usually want deep-cycle rechargeable batteries.

Secondary batteries — while initially more expen-

sive — are cheaper in the long run. Typically, secondary batteries can be recharged 200 to 1,000 times. In many cases, a simple recharging circuit can be built into the project so that it becomes unnecessary to remove batteries for charging.

Rating Primary Batteries

As you may have guessed, there are a number of primary batteries available. The differences in batteries relate to the chemistry used in the battery to produce electricity. The choice of a primary battery is a trade-off of price vs. energy density, shelf life, temperature range, discharge slope, and peak current capacity.

Carbon-Zinc — At the low end of primary batteries, is the carbon-zinc battery. This battery hasn't changed much since 1868 when it was developed by George Leclanche. Carbon batteries have a low-energy density (1-2Wh/cubic inch), poor high-current performance, sloping discharge curve, and bad low-temperature performance. Cost: inexpensive, but obsolete.

Alkaline-manganese — Sold as simply Alkaline batteries. Energy density 2-3Wh/cubic inch. Improved low-temperature performance. Sloping discharge curve, not as severe as carbon-zinc batteries. Cost: moderate.

Lithium — Premium battery. High-energy density (8Wh/cubic inch). Excellent low-temperature and high-temperature performance. Long shelf life (+ five years), and lightweight. Cost: expensive.

Rating Secondary Batteries

NiCads and sealed lead-acid batteries are the most common rechargeables, with NiCads being the more popular of the two. Both types of batteries have lower energy densities than primary batteries.

NiCads only provide 1.2 volts per cell, in comparison to 1.5 volts per cell of the primary batteries. Manufacturers claim that NiCads are good for 200-1,000 charge/recharge cycles. However, NiCads will die fast if they aren't recharged properly. The life expectancy of NiCads are two-four years. A fully charged NiCad battery will lose its charge in 30-60 days without use.

NiCads are designed to be recharged at 10% of their rated capacity. Meaning that if a particular NiCad battery is rated at 1 ampere-hour (1Ah), it is safe to recharge the battery at 100 mA (1 amp / 10 = 100 mA). The terminology used to describe the above recommended recharge rate is "C/10."

Because of inefficiencies, it is necessary to charge the battery for more than the expected 10 hours at

C/10. It takes approximately 14 hours to get a full charge. While manufacturers claim that it is okay to overcharge NiCad batteries at the C/10 rate, most engineers recommend to switch over to a trickle charge after the initial 14 hours at C/10. A trickle charge is usually rated at C/30 or (1/30) of the battery's capacity. A trickle charge for our 1 Ah battery would be around 33 mA (1 amp / 30 = 33.3 mA).

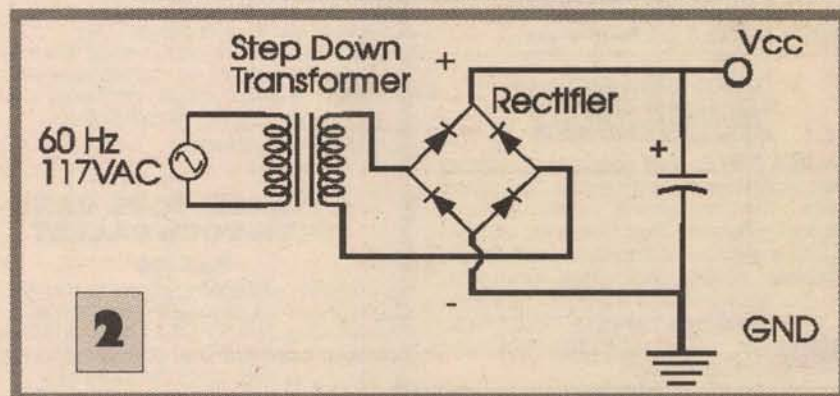
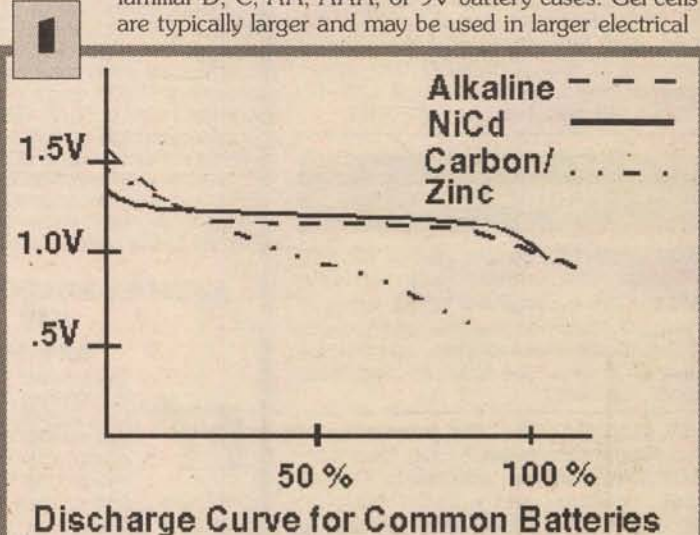
Memory Effect

A disadvantage to NiCads is the memory effect. If one repeatedly recharges a NiCad battery before it has completely discharged, the batteries form a memory at

that recharge level. It then becomes difficult to discharge the battery past that remembered level. Obviously, this can severely limit the battery's capacity. To correct that problem, the battery must be completely discharged by leaving a load connect to the battery for several hours. Once the battery is completely discharged, it can be charged normally, and will function properly.

Lead Acid

Gelled-electrolyte battery cells (gel-cells) are similar to automotive batteries. They are sealed, maintenance free lead-acid batteries. They don't make gel-cells in the familiar D, C, AA, AAA, or 9V battery cases. Gel-cells are typically larger and may be used in larger electrical



systems.

Gel-cells are available in numerous voltage ratings from 2 to 24 volts and current capacities. These batteries may be charged with a current-limited constant voltage or a constant current like NiCads. Typically, to charge a gel-cell, one applies a fixed 2.3 volts-2.6 volts per cell. Initially, the battery will draw a high current that tapers down as it charges. When fully charged, the battery needs to only draw just a trickle charge (approximately C/500) to maintain itself in a fully charged state.

Gel-cell batteries vary from manufacturer to manufacturer. To safely recharge a gel-cell, you should check the manufacturer's recommendations. In general, a simple charging device can be made using a LM317 voltage regulator. A fixed voltage (2.3 volts per cell), constant current C/10 is applied to the battery. When the battery reaches a full charge, the constant current source is removed and a regulated voltage is applied.

Many gel-cell batteries do not like to be deep-cycled. Therefore, it becomes necessary to monitor battery voltage under load. When battery voltage drops by a specified amount (check manufacturer's data sheet), it needs to be charged.

In General

Most people use Alkaline batteries when a primary battery is called for, and NiCads when secondary batteries are needed.

NiCad Battery Charger

NiCads battery chargers are inexpensive. Typically, it is not worth the time and effort to build a stand-alone charger for common size batteries: AAA, AA, C, D, and 9V. However, most inexpensive chargers charge only at the C/10 rate, even after the batteries have received a full charge after 14 hours.

The charger we will build will drop the current down to a C/30 rate after the batteries are fully charged. This is the recommended procedure for charging NiCad batteries. This will help provide a long service life to the battery.

In addition, if you want to design a system for charging a particular battery pack or to charge batteries without removing batteries from a project, then a custom NiCad charger is the way to go.

The power for the charger is supplied by either a standard transformer or a VDC plug-in wall transformer. I would choose a wall transformer because it supplies a DC voltage. If one uses a standard transformer, you must build the power supply using a line cord, switch, fuse, bridge rectifier, and smoothing capacitor.

In either case, you should match the transformer (or wall transformer) power output to the battery pack

Current Limiting Resistor

Most NiCad battery manufacturers recommend charging the battery at 1/10 of its rated capacity, referred to as C/10. So if a "AA" battery is rated at .850 amp hours (AH), it should be charged at 1/10 that capacity or 85 mA for 14 hours.

After the batteries are fully charged, manufacturers recommend dropping the current to around C/30 (1/30 of battery capacity) to keep them fully charged without overcharging or damaging the batteries in any way.

For our example, we will configure the charger to recharge four "C" cells in series. Each "C" cell is rated at 2000 mA. So our C/10 rate is 200 mA. The typical voltage rating from this battery is approximately 1.3 volts ($4 \times 1.3V = 5.2V$). We can use a six-volt transformer with at least a 200 mA output. To calculate the current limiting resistor use the formula:

$$R = 1.25/I_{cc}$$

where I_{cc} is the desired current. Plug in our 200 mA (0.2 amp) yields:

$$1.25/.2 = 6.25 \text{ ohms}$$

The current limiting resistor for this charger should be around 6.25 ohms. In the schematic, this resistor is labeled R2. Notice the R2 value listed in the schematic is 5 ohms. You should choose a common resistor value as close as possible to the calculated value.

C/30 Resistor

To drop the current to a C/30 range, we add another resistor whose value is 2R, or about 12.5 ohms. In the schematic, this resistor is labeled R3. Again a resistor with the closest value to the calculated value is used. In this case, the value is 10 ohms.

How the Charger Works

The charger uses an LM317 voltage regulator as a constant current source. The C/10 current limiting resistor is identified as R2 in the schematic. R2, you

will notice, is only 5 ohms as compared to the calculated 6.25 ohms. This standard value is close enough to the calculated value for proper operation. The C/30 resistor is R3 on the schematic. Again, the standard value of 10 ohms is close enough to the calculated value for proper operation. Later on, we will see that it's possible to fast charge the batteries because of the voltage sensing capacity of the circuit.

V1 is a 5K potentiometer. It is set to trigger the SCR when the NiCad batteries are fully charged. The SCR, once triggered, allows current to flow

through a DPDT relay.

When power is applied to the circuit current flows through the LM317, charging the batteries at a C/10 rate. Resistor R3 is shorted by one half of the DPDT relay. Current also flows through resistor R1, which is a current limiting resistor for LED's D1 and D2. Upon power up, the red LED D1 will be lit. When the red LED is lit, this means the circuit is charging.

As the batteries charge, the voltage drop across V1 begins to climb. After about 14 hours, the voltage drop across V1 is great enough to trigger the SCR. When the SCR is triggered, current flows through the coil of the DPDT relay. The relay switches, causing the red

PARTS LIST

U1	LM317 Voltage Regulator
L1	DPDT Relay (5V or 12V)
D1	Red LED
D2	Green LED
D3	1N4004
Q1	SCR 200 volt 6 amp
V1	5K PC Mounted Potentiometer
R1	330 ohm 1/4 watt
R2	5 ohm 2 watt
R3	10 ohm 2 watt
R4	220 ohm 1/4 watt
	Wall Transformer (see text)

LED to go out and the green LED to turn on. The green LED signals that the batteries are fully charged. The other half of the relay switches open up the short on resistor R3. With R3 now in the current path, the current flowing to the NiCad batteries is cut to a C/30 level.

Diode D3 prevents any current from the batteries flowing back into the circuit.

Determining the Trigger Voltage from V1

For the circuit to function properly, the SCR must turn on when the NiCad batteries are fully charged. The easiest (best) way to do this is to place depleted batteries in the charger, charge the batteries for 14 hours, then adjust V1 until it triggers. With fully charged batteries, slowly turn V1 until the relay clicks and the green LED turns on.

Design Notes

When building a charger for your application, keep these points in mind. The main considerations are choosing the C/10 and C/30 current limiting resistors. Use the formulas described previously for selecting these values. Current limiting resistors should be rated around two watts.

If charging current is high (greater than 250 mA), heatsink the LM317.

If the charger switched on without the NiCads connected, the relay will switch immediately, turning on the green LED and providing a C/30 current.

When building a charger for higher voltages, increase the value of R1 proportionally to limit the current flowing through the LEDs. For instance: for a 12-volt unit, make R1 680 ohms; for a 24-volt unit make R1 1.2K ohms.

At high voltages, you may need a low ohm value current limiting resistor connected to the DPDT relay. Measure the current C/10 and C/30 current flowing to the batteries. These measurements will insure that the proper current is being supplied to the batteries.

Series/Parallel Charging

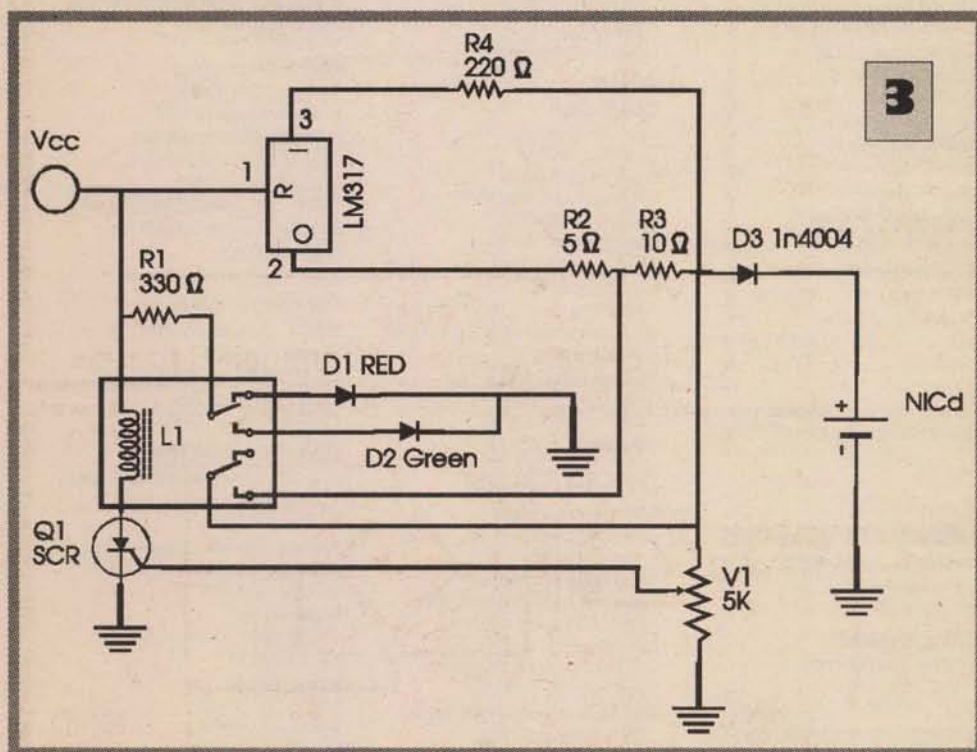
How the batteries are configured determines the voltage and current of the transformer one should use. If you have eight "C" battery cells in parallel, you need to multiple the current requirements of each individual cell by eight. If the cell is rated at 1200 mAh, the C/10 requirement per battery is 120 mA.

For eight cells in parallel ($8 \times 120 \text{ mA} = 960 \text{ mA}$), you need close to one amp (.96 amp) of current. The voltage required is, just 1.5 volts. The ideal transformer's output would be 1.5 volts @ 1 amp. If the eight cells were held in series, the current requirements would be 120 mA at 12 volts.

Fast Charger

Many of today's NiCads are capable of accepting a fast charge provided that the circuit can sense when the batteries are fully charged and drop the current to C/30. Typically, to fast charge a battery, you double the current for half the time. So, you charge a battery at C/5 for seven hours.

Although I haven't tried the above circuit for fast charging, there is no reason why it wouldn't work. You may want to start with a C/10 charging current and adjust V1, then switch out resistor R2 for one with half the value. NV



you are charging. Matching the voltage and current of the transformer to the battery pack reduces the power the LM317 must dissipate. For instance, you don't want to use a 12-volt transformer to charge a 6-volt battery pack.

Figure 2 is a basic VDC power supply. The power supply can be made to provide either 6V, 12V, 18V, 24V, or 36V, depending upon the transformer chosen.

The charger circuit is illustrated in Figure 3. It uses a LM317 voltage regulator and a current limiting resistor. The current limiting resistor is calculated depending upon the current needed to charge the battery.

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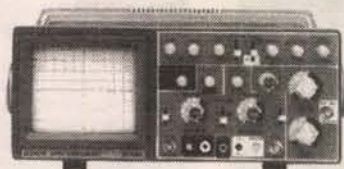
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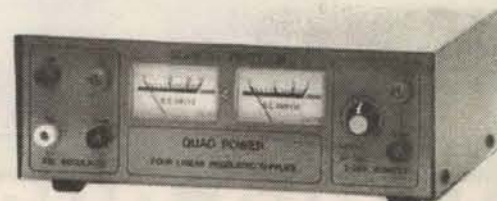
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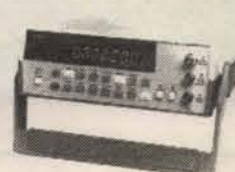
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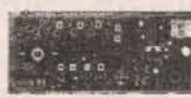
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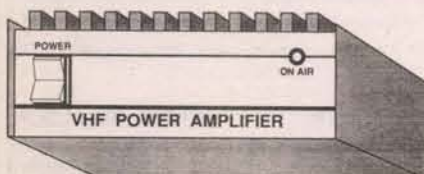
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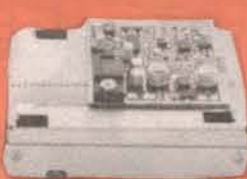
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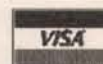


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by Karl Lunt

Fall Clean-up

I

t's the end of October here in the Pacific Northwest, and time for fall clean-up. Those with outdoor interests rake the leaves, clean the gutters, and prepare the garden for the long winter months. I, however, close out those long-standing robot projects that have piled up on my desk, workbench, and floor.

Hercules

I've seen some tiny robots in my day. The smallest by far is Goliath, a robot made by MIT students in the Robot Lab. Goliath measures less than a cubic inch, yet includes a 68hc11 with sound, light, and bump sensors. The little machine uses surplus pager motors for drive power, and the circuit boards and MCU form the mechanical frame. It is a miniature work of art, and started me thinking about making a small robot of my own.

I don't have ready access to the machining tools used to fabricate Goliath, but I was curious about just how small a robot I could make, given nothing more sophisticated than workbench tools and a Radio Shack. You can see the results in the accompanying photos of Hercules.

I built Hercules from a 68hc811e2 BOTBoard and a Radio Shack four-cell AA-battery holder. The underside of the battery holder forms the frame for mounting the motors and front skid. The BOTBoard rests on top of the battery pack,

nylon sleeve and the skid's metal threads with hot glue and let it set. That's it!

I pulled the motors from my junk box of spare robot parts. They are beautiful ball-bearing gearhead motors that I picked up long ago from some surplus store, so you are unfortunately on your own here. My motors measure slightly over 0.5" in diameter, with an overall length of 1-3/8", not including the shaft. These dimensions made them a perfect fit for the 2-1/2" wide battery holder.

I could have simply hot-glued the motors to the battery holder, but it's hard to get the alignment right when you're mounting a cylinder to a flat surface, and you don't get a lot of surface contact area. The latter can lead to a weak mechanical connection. I found the perfect item in my junk box; a pair of C-shaped metal snap-in clamps, used to hold large electrolytic capacitors. I simply snapped a motor into a clamp, then hot-glued the clamp to the battery holder. As a bonus, the clamp lets you reposition the motor laterally, so you have a little flexibility in alignment, even with the clamp firmly glued in place.

Choosing suitable wheels and mounting them on the motor shafts presented a problem. The

onto the shaft; it fit like a glove. Finally, I pulled the wheel back off, filled the bore with hot glue, then pressed the wheel back onto the shaft. When the glue set, the wheel was firmly (and I mean firmly) seated on the motor shaft.

The major challenge in building such a small 'bot lies with the motor drivers. For Hercules, I used drivers built from a pair of TelCom Semiconductors TC4427 power MOSFET drivers. Each eight-pin DIP device contains a full MOSFET H-bridge rated at 1.5 amps (peak), which gives me plenty of current for my tiny 6 VDC gearhead motors.

I've mentioned this chip before; its small size, digital inputs, and ability to use a separate, higher motor voltage make it a natural for small machines. And the accompanying schematic shows that the hook-up is a no-brainer. The two motor drivers fit comfortably in the compact prototyping area on the BOTBoard, and at \$1.79 in singles from Digi-Key, the 4427 is a cheap low-power H-bridge.

I wired my motor drivers to bits PB2 through PB5 on the BOTBoard; I also have a two-color LED hooked to PB0 and PB1. To change motor direction and LED color, I simply write a new value to port B. Since the gearhead motors move so slowly, I didn't need to bother with pulse-width modulation (PWM) speed control. The following chunk of SBasic code shows how easy it is to control the two motors:

```
' Declare motor and LED constants
' for port B.
```

```
const FWD = %010111
const LEFT = %011001
const RIGHT = %100110
const STOP = %000000
```

```
' Move forward
```

```
pokeb portb, FWD
```

Hercules, like many of my robot projects, is evolving. For now, it serves as a base for behavior experiments. I've added two photocells for sensing ambient light, and have lots of port lines left for adding other sensors and actuators. Right now, the biggest obstacle is finding room on the BOTBoard or frame for adding more electronic circuitry.

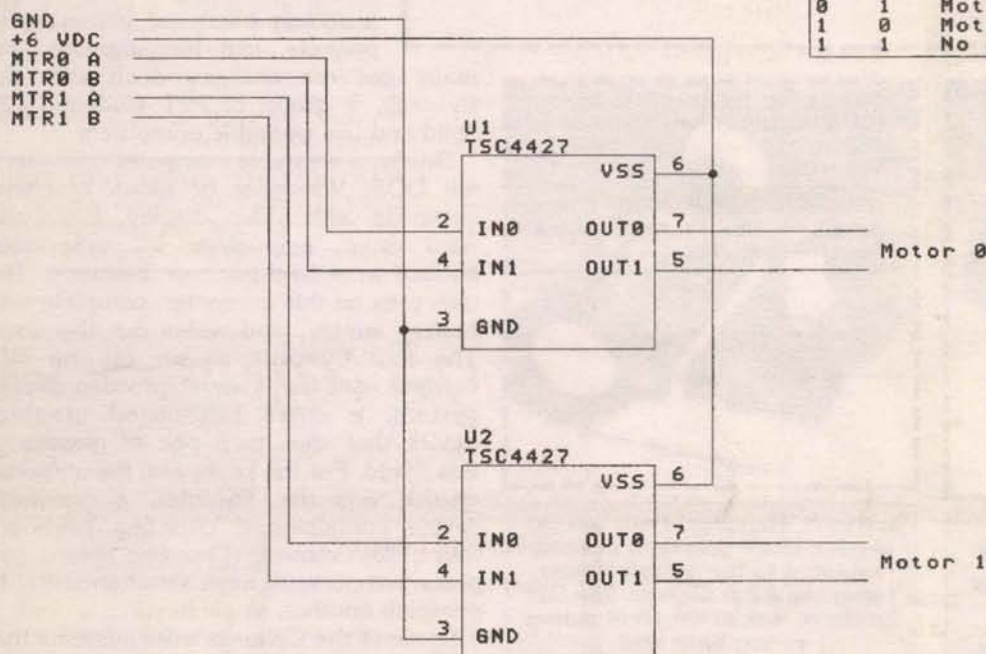
But Hercules shows how quickly you can build a bantam 'bot; I have about one weekend in Herc. If you built just one a week, you could have a fleet of four going in a month. Add a little software for herd or swarm behavior, and you'll knock 'em dead at the next club meeting.

Lots O' Ports

One recent 68hc11 robot project required 24 output-only I/O lines, each capable of handling at least 250 mA. This seemed like a natural for the 68hc11 Serial Peripheral Interface (SPI), Motorola's high-speed synchronous serial bus. I've already used the 74hc595 serial-to-parallel converter chip on other projects, such as my serial LCD driver. It works very well with the SPI, and its serial output line lets you chain together as many 74hc595s as you need. Refer to the accompanying schematic.

Unfortunately, the 74hc595 output lines can't

SCHEMATIC OF HERCULES' MOTOR DRIVERS



Motor Function Table

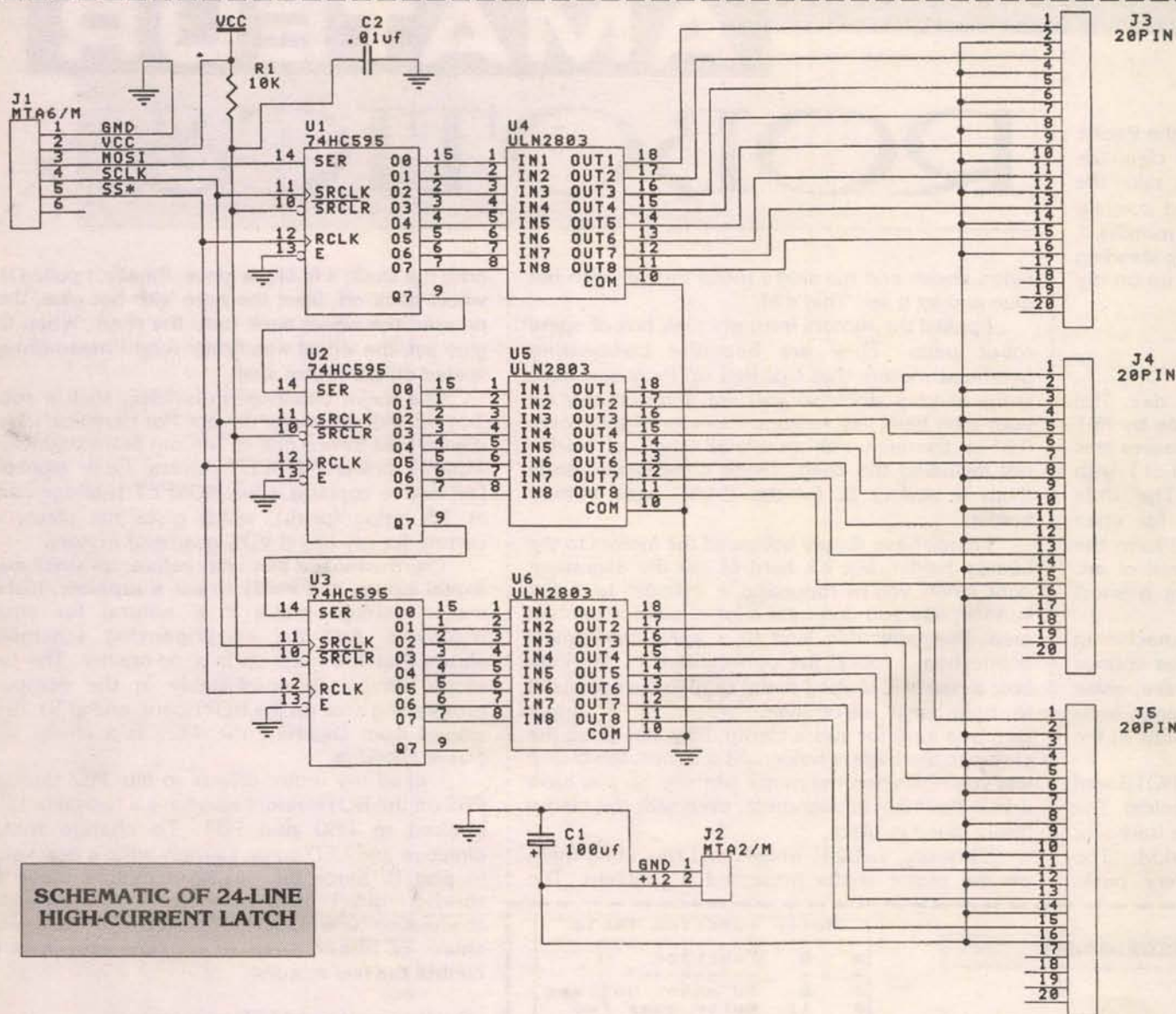
A	B	Function
-	-	-----
0	0	No motor voltage
0	1	Motor goes fwd
1	0	Motor goes bkwd
1	1	No motor voltage

protected from contacting the batteries with a piece of thin cardboard cut from a business card. I used an elastic restraining tool (rubber band) to hold the BOTBoard in place.

The front skid is a metal furniture foot, sold in packs of four at most hardware stores. I shopped around until I found a style that included threaded studs on the feet, so the skid's height is adjustable. Mounting the skid to the bottom of the battery holder becomes a simple, two-step process. First, hot-glue the nylon sleeve of the skid to the battery holder in the proper location, then let the glue set. Next, screw the metal part of the skid into the sleeve and adjust to the proper height. When you've got the right height, coat the junction of the

motors have very thin shafts, slightly less than 0.1" in diameter. My usual wheels, the Dave Brown Lite-Flite items, were right out; far too large. I rooted through my junk box again and came up with some old Red Pepper racers I had purchased at a Radio Shack long ago. I ripped a couple of wheels off their shafts and checked the fit. The axle bore was still too large, but only by 1/16th inch or so.

To make the wheel fit firmly on the motor shaft, I first cut a piece of 3/32" heatshrink to a length slightly longer than the motor shaft. I slipped the heatshrink over the motor shaft, then shrank it down. This left a soft plastic cover firmly bonded to the motor shaft, and also expanded the motor shaft considerably. Next, I pressed a wheel



control this super latch is much like using a single 74hc595 serial latch. My 68hc11 software must pull the slave-select (*SS) line low, then set the master-out-slave-in (MOSI) line to the desired level and pulse the clock (SCLK) line. After sending out 24 pulses with the proper data level on MOSI, my software must pull *SS back high. This last change causes all 74hc595s to simultaneously transfer the newly-received data to their respective output lines.

This is only slightly more complicated than the usual SPI transfer. The chunk of SBasic code in Program 1 shows how easily you can update all 24 outputs. Remember also that this transfer takes place at two megabits per second, since the 68hc11 SPI subsystem handles the transfers in hardware.

In the past, I've sold some of my project PCBs through the mail. I won't be selling this board, however. The circuit is very simple, and you shouldn't have any trouble wiring one up using the Radio Shack experimenter boards or wirewrap.

Embedded PCs

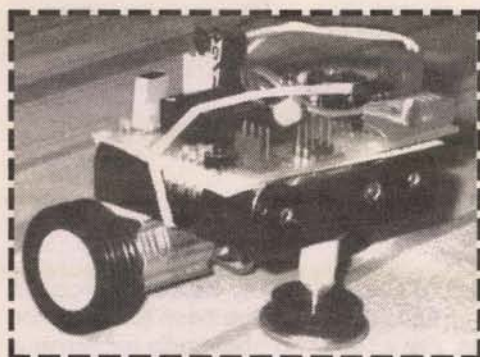
The first show of the new season for Scientific American Frontiers featured several ongoing projects at MIT's Media Lab. This show aired in October, and Alan Alda, the show's host, demonstrated some way-cool technology, including plenty of virtual-reality projects. But the segment that

really got me charged dealt with the Cyborgs, a group of MIT students who build and use wearable computers.

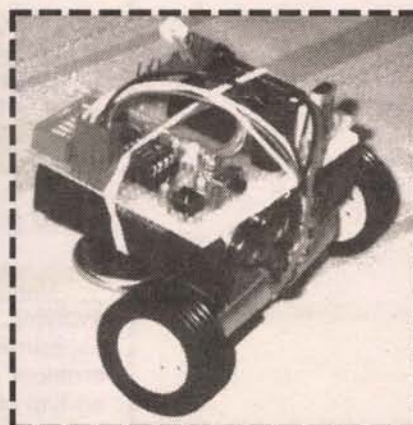
Briefly, a wearable computer contains a full DOS, Windows, or Linux machine, complete with video display, keyboard, hard drive, and other PC essentials, housed in a backpack or belt-pack. The user puts on this computer, complete with battery supply, and walks out the door. The five Cyborgs shown on the MIT campus used the Private Eye video display system, a small LED-based graphics device that clips to a pair of glasses or headband. For the keyboard, the universal choice was the Twiddler, a one-hand device containing a chording keyboard with built-in mouse. (Chording means you press two or more keys simultaneously to generate another, single key.)

Some of the Cyborgs wore systems that included RF modems, letting them become mobile links within the school's intranet, which, in turn, made such a wearable computer a moving node on the Internet. Someone sitting at a desktop PC in the Media Lab could connect to a modem-equipped Cyborg and exchange E-Mail or chat directly. And if the Cyborg system included a live video camera, as one system did, the chair-bound viewer could see what the Cyborg saw, using a small MPEG window.

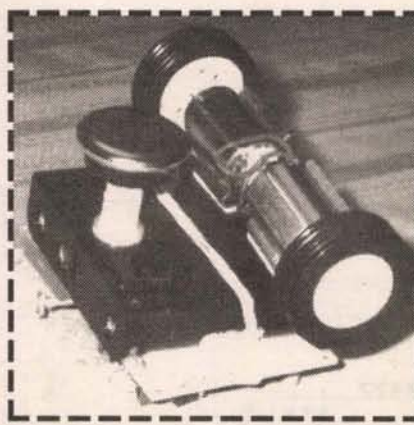
My robotics interest in all this stems from the PC used to drive the Cyborg systems. You can't grab some motherboard, hook it to a battery, and expect any decent results. First off, many of the motherboards require ± 12 VDC supplies to function. Secondly, since the designers knew in



Hercules stands less than three inches tall and measures only four inches across. Here you can see the BOTBoard strapped to the four-cell battery holder that serves as power source and mechanical frame.



Another view of Hercules, showing the circuitry I added to the BOTBoard's prototyping area. The rubber band runs alongside one of the TC4427 motor driver ICs; two photocells look out from either side of the front.



Roll over, Hercules! Here you can see the small gearhead motors, mounted to the battery holder using capacitor clamps. The flat furniture foot at the front makes an excellent skid.

supply a lot of current. To get the required oomph, I followed each 74hc595 with a ULN2803 high-current driver. Many companies make this octal driver IC; my prototype circuit uses Motorola parts, but devices by SGS-Thompson and others will work as well. This chip contains eight power Darlington drivers with built-in snubbing diodes, so you can use the outputs to directly switch relays or other inductive devices, without fear that back EMF could fry the driver chip.

My schematic uses three separate IDC connectors, one for each of the eight-bit output ports. On the connectors, I've matched each output line with a ground line, keeping the grounds on even-numbered pins. This arrangement lends itself to hacking. You can mount male IDC headers

in the connector layouts, then use a two-pin female connector to hook up just one output line, if you want to try a quickie experiment.

I could have used 16-pin IDC connectors for J3 through J5, but I intentionally used a 20-pin layout so I could take advantage of the cheap XT floppy disc cables available at local surplus stores. For a buck or so, I can buy a two-foot cable complete with 20-pin connector, which gives me a cheap, high-quality solution to my cabling problem.

Wired as shown, the three 74hc595 ICs form a large, 24-bit SPI power output latch. I brought the necessary SPI signals and logic power line out on a six-pin male MTA connector. Using the SPI to

ROBOTICS ... ROBOTICS ... ROBOTICS ... ROBOTICS ... ROBOTICS

advance you would have a 230-watt supply sitting in your case, they took no pains to reduce power consumption. And I won't even mention the

difficulties with physically mounting such a large board, or maintaining good mechanical and electrical connections with all the necessary plug-in peripheral boards.

No, for either a wearable computer or a PC-based robot platform you need a small, low-power, fully-contained PC single-board computer (SBC). For robotics, I would extend this to include solid-state bootable RAM or flash EPROM drives, to cut down even further on power consumption and mechanical weight and fragility.

So I began a search for the perfect PC SBC. I found several that got close, but weren't exactly right for one reason or another. Usually this was power draw; I really wanted an SBC that could run on less than 3 watts, which is only 600 mA at 5 VDC. And I dismissed any SBC that required any voltages other than 5 VDC, even if it only needed a few milliamps.

Finally, I found the WinSystems 386SX PC-104 module. This board, dubbed the PCM-SX, measures only 3.6" by 3.8", weighs just 2.5 ounces, and draws a mere 375 mA from its lone 5 VDC supply. You get a 386SX CPU running at 40 MHz, complete with two serial ports, one parallel port, an IDE hard-drive controller, floppy disc controller, and a standard PC-104 bus connector for expansion. The board can boot off of a single 32-pin memory device,

Notable Web Sites

Check out the MIT Wearable Computing Web Page at:

<http://wearables.www.media.mit.edu/projects/wearables/>

Yes, the address is a mouthful, but the lead-in image is terrific, and the site contains pages and links of interest to anyone working on low-power or mobile computing. The hardware and software sections can help you find low-cost or rugged peripherals that have stood the test of Cyborg use, and other sections will guide you to worthwhile commercial and academic sites.

WinSystems, Inc., sells a broad range of PC SBCs in PC-104 and STD form-factors. Their web site at www.winsystems.com includes some good graphics images, but more importantly, you can see actual technical data. Unfortunately, you still need to actually call or E-Mail to get pricing. The company offers a good set of development tools, as well, which should ease the construction of that PC-based robot or wearable.

which currently gives you the options of a 512 KB SRAM or flash, a 1 MB EPROM, or the 12 MB DiskOnChip device available from MSystems.

As I write this, the WinSystems board is targeted for production in January, priced at \$395.00 in singles. From my research, this is a smoking deal, and I hope to have one in my hands by the time you read this. I'll give you an update later. If you'd like a look at the WinSystems' 386SX board, or any of the company's large array of products, stop by their excellent web site at www.winsystems.com NV

PROGRAM ONE

SendSPI() send 3 bytes to SPI

Enter with the three bytes pushed onto the data stack.
Remember that the bytes will go out right to left!

SendSPI:

pokeb portd, peekb(portd) and \$df
pokeb spdr, pull()
waituntil spsr, \$80
pokeb spdr, pull()
waituntil spsr, \$80
pokeb spdr, pull()
waituntil spsr, \$80
pokeb portd, peekb(portd) or \$20
return

'pull SS low
'send without checking
'wait until transfer done
'send second byte
'wait until transfer done
'send third byte
'wait until transfer done
'pull SS high

Send three bytes to SPI super-latch.

gosub SendSPI, \$33, \$22, \$11

'\$11 goes out first!

As always, you can reach me at:

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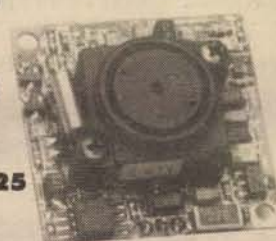
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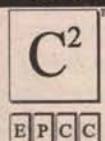
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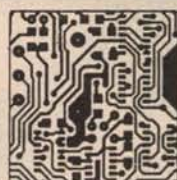
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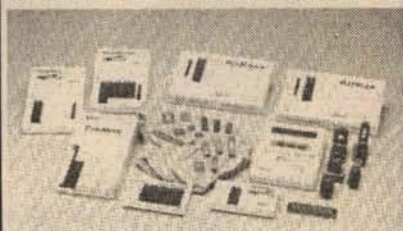
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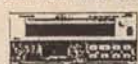
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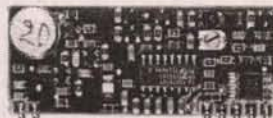
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ELECTRONICS

Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware and software. This column doesn't replace the Tech Forum that you've grown to love and support. Instead, it will supplement it, so feel free to participate as always with your questions and answers. You can reach me on America Online at TJBYSERS, on the Internet at TJBYSERS@aol.com or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 91719.

No-Cook Solar Recipe

Q. I plan on building a very simple solar charger for a 12-volt battery to power a motion-sensitive light. Since the light won't be on as much as it's off, I'm concerned about overcharging and cooking the battery. Can you give me any advice?

Lance
via Internet

A. Check out this month's N&V Solar Workshop on page 48. This time I tell you how to choose a solar battery and how to keep it from cooking — exactly what you're looking for.

Too Many Commands

Q. When I type MEM /C, I see that I have two COMMAND.COM files instead of one. I'd like to free up more memory by getting rid of the duplicate, but despite my efforts, it persists. Why does it exist and how can I eliminate it?

Lester Stowe
via Internet

A. The reason it looks like you have two COMMAND.COM files running at the same time is because you're looking at MEM from a Windows shell. Windows is loaded on top of COMMAND.COM (DOS). So when you shell from Windows to DOS, another COMMAND.COM interpreter must be loaded to prevent Windows from crashing. Nonetheless, don't worry about the mere 3K this file is taking up. There are a lot more things you don't see that eat up a lot more memory.

From a Fax to a Scanner

Q. I've heard you can use a fax machine as a scanner by faxing a document to yourself and saving it as a file. So I tried it. I must say it works great for graphics, but not text. I can't seem to get the words into ASCII format for import to my WinWord 95 program. Any thoughts?

Spegal
via America Online

A. The missing piece of the puzzle is an optical-character-recognition program, or OCR. This software converts scanned text into ASCII, WordPerfect, and other word-processing formats. Here's how it works: The software first scans the page and saves it as a bit map. Next, it converts the dots (which make up the characters that look like letters and symbols) into ASCII code by comparing the dot pattern to patterns it has stored in memory. Basically, it's a matching game. The problem is that the conversion process isn't perfect. Often fax characters have broken or missing pieces that are caused by dirt, smudges, or just lousy hard copy. Beyond that, there are hundreds of different fonts, some of which are very strange. Proportionally-spaced type is particularly difficult to identify. A good OCR program will have a "hit" rate of 90 percent or better, which means you have to go into the document and fix up to 10 percent of the garbled mess. However, that's a whole lot better than entering the data manually from square one. Many vendors sell OCR software, mostly packaged with scanning or fax hardware. But if you'd like to take a shot at it, I've uploaded a copy of OCRSH22.ZIP, a shareware OCR program, on our Web site at <http://www.nutsvolts.com>. It works as good as most, but as always, not perfectly. I can't say enough that when it comes to computer software, experiment. Just make sure you have a good back-up before you take the plunge!

Not Loud Enough?

Q. I'm looking for a simple preamp circuit to boost the output from my microphone to my Sound Blaster card. The fewer the parts, the better.

Ray Stacy
Rochester, NY

A. Actually, I think you're looking in the wrong direction for an audio boost. The Sound Blaster card is pretty sensitive, so I'd suspect a problem in the impedance connection in the microphone interface, if that's really the problem. As for the Sound Blaster itself, it only puts out about four watts, which isn't loud. If you want louder, buy an amplifier speaker, like one of the many models Labtek makes.

Anti-Abort, Retry, Fail

Q. Is there any way that I can avoid getting trapped in the whirlpool of the "Abort, Retry, Fail" prompt, but go instead to some prompt that I can immediately answer with an effective command?

I. C. Skylla
Fresno, CA

A. A handy undocumented feature will carry your ship to clear seas: Simply add the /F switch to the end of your CONFIG.SYS SHELL line and you'll never look at that vortex again. For example, if your SHELL line reads: SHELL=C:\COMMAND.COM /P /E:416, just add an /F at the end (as in "E:416 /F") and instead of responding with "Abort, Retry, Fail?" DOS will give you the prompt "Current drive is no longer valid." Just tell DOS which drive you want to be valid and you'll sail free again.

Repressing Memory in a Notebook Battery

Q. I've just gotten an Epson ActionNote computer, the first notebook computer I've used. I seem to have killed the battery very fast, although I recharge it after nearly every use. A dorm-mate says that my battery has developed a "memory." Can you tell me what he's talking about — and tell me how to fix it?

Horst Badorties
Ann Arbor, MI

A. Most notebook computers are powered by batteries based on nickel-cadmium (abbreviated Ni-Cd), the same as are used in rechargeable flashlights and cordless power tools. The memory effect occurs when you habitually use such a battery for a short period of time — say, 15 minutes — and then recharge it. Do this often enough and the battery "remembers" this cycle and thinks that's all the work it will ever have to do. From then on, after 15 minutes, it simply quits, even though it may have another three or four hours of battery life left. To avoid giving the battery this destructive memory, deeply discharge the battery before you recharge it. You can do this by letting the notebook run all night (doo-dah) while you're sleeping. However, like you, the notebook also has a built-in sleep mode, which you'll have to disable before you try to discharge the battery, or it'll take weeks before the battery is drained. The following batch file will give the notebook insomnia:

```
:wakeup
dir. c:
goto wakeup
```

Ni-Cd batteries that have developed a memory can be saved the same way: by deep-discharging them several times to erase the memory. Once you've recharged the battery, don't recharge it again until the battery is genuinely running low, e.g., after a good eight hours' use. You could also switch to a new type of battery, called nickel metal hydride (NiMH, abbreviated MH). It carries more power than NiCd for the same weight, and it doesn't suffer from memory problems.

Virtual Instruments

Q. I would like to have a multimeter with a computer disk attached where I could take readings and record them onto the disk, after which I could take the disk and put it in my computer. I would be able to watch every wave form, fluctuation, spike, and drop in every microsecond of the recording. It would also be handy to have this on a scope, too. Does such a thing exist?

via Internet

A. You betcha! They're called virtual instruments (VI), and they come from a lot of different vendors, a list of which you see below.

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Shushing the Howling Modem

Q. I often need to use my modem at night, after my husband has gone to sleep in the next room. Can you tell me any way to make a modem dial silently (or quietly, anyway), without howling and beeping?

Vickie Valetta
via America Online

A. Depending on your modem and your software program, you can usually make the modem shut up. If your modem is Hayes-compatible (which most are), you can add the ATMO command to your start-up string. In "ATMO," "AT" indicates the modem, "MO" indicates the modem's speaker. The ATMO command can set the volume so low that you can't hear it. However, every communications software application has a different way to apply Hayes AT commands. To do it in Procomm Plus, for example, you select MODEM OPTIONS from the Setup Main Menu and then GENERAL OPTIONS from the Setup Modem Options Menu. The first line, Initializing command, is where you insert the following:

ATMO S7=255 S11=55 V1 X1 SO=1 ^M

This string of commands tells the modem (AT) to turn off the speaker (MO), wait 255 seconds for an answer (S7=255), use 55-ms tone spacing when dialing (S11=55), display words rather than numbers (V1), use the expand Procomm Plus command set (X1), answer on the first ring (SO=1), and end the string (^M). Other software may have additional command options and different ways to program the string, but as long as the ATMO command is included, the speaker will be silent. After entering the command string, save it. It will then run every time you load the communications software, so you have to program it only once.

Continued on page 116

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Anthony Charlton

8/31/55 - 9/22/96

Anthony Charlton passed away recently. He died unexpectedly ... it came as a shock to me and everyone who knew Anthony personally.

Anthony and I are both writers with a keen interest in exploring science and nature. We met through our writing seven or eight years ago, and became friends.

Although Anthony lived in Connecticut and I live in NYC, we spoke over the telephone often. We made plans ... plans to get together some time in the future, plans to work on some projects together, we even kicked around the idea of writing a book.

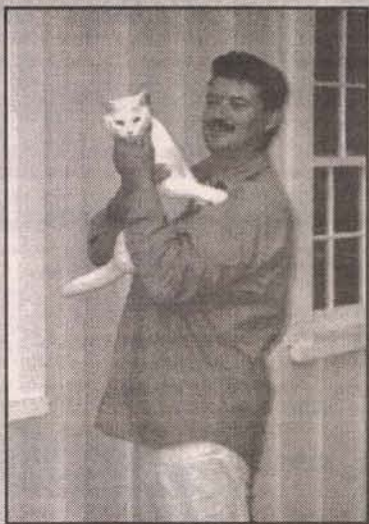
We never got around to meeting in person. I didn't even know what Anthony looked like until I received a picture of him from his girlfriend. I enjoyed the conversations we had. It was nice having someone who understood the technical aspects of what I was talking about to bounce ideas off of, and vice versa.

Anthony loved exploring science and electronics. He subsidized his exploration through writing. Most of you knew Anthony through his writing, and his writing will be missed by us all. I know his best work had yet to be started.

Anthony was one of the good guys. Anytime I spoke to him, I felt the honesty and integrity in his voice, actions, and deeds. That, in itself, was quite refreshing. So anyone who appreciated Anthony's articles, give a moment to say goodbye.

Bye, Pal.

John Iovine, NYC



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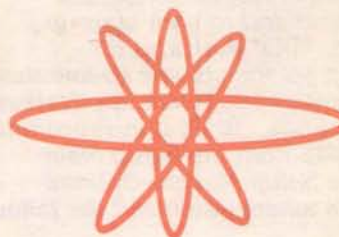
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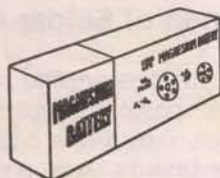
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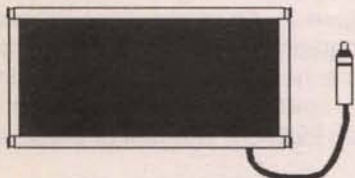
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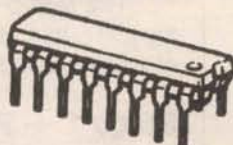
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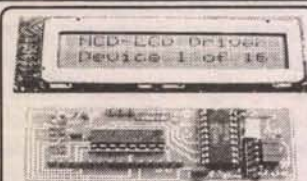
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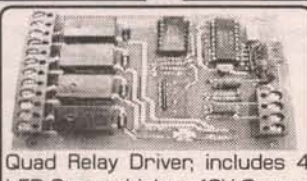
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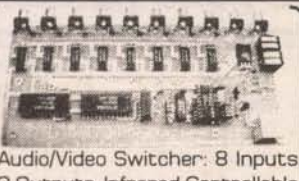
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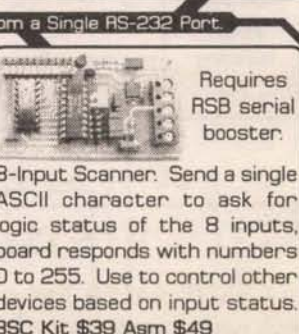
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Nuts & Volts Magazine/December 1996 93

Industrial SMT Assembly:

by Ronald Reis

Look, No Hands!

You've seen "them," that is, if your eyesight is good enough. They permeate, penetrate, pervade, infuse, and saturate today's electronic circuits.

They are found not only on one side, but, in many cases, on both sides, of a printed circuit board. "They," of course, are surface mount devices (SMDs), and they represent a component packaging revolution.

You (like me) have probably wondered how these devices, often smaller than a grain of rice, can possibly be assembled onto a printed circuit board? Surely, no human can do it?

To answer that question, to find out how industrial SMT assembly takes place, I did some research, then visited an actual SMT assembly firm, Micree Corporation. I hope you'll find what I found to be of keen interest. I know I'll never look at those teeny resistors, capacitors, transistors, or integrated circuits quite the same again.

Industrial SMT Assembly: Humans Need Not Apply

It turns out from its origin, surface mount assembly was designed to be fully automated. True, some SMT prototypes are assembled by hand, as are a few low-population, very-low volume production boards. Anything more, however, requires the use of automatic pick-and-place machines and flow or reflow soldering equipment.

Essentially, there are two types of automated assembly, both identified by the method they use to solder SMDs to a printed circuit board: the reflow process and the flow (wave) process. In this article, we'll concentrate on the former since it is, at least in the United States, the more widely used procedure.

In the reflow process, six stages can be identified (see Figure 1).

First, incoming SMT PC boards are visually inspected for defects.

Second, solder paste is applied to SMD pads (footprints) by a silk-screening (printing) operation.

Third, individual surface mount components are automatically picked up and placed on the PC board.

Fourth, the entire printed board is heated until the solder melts, or reflows. detailed discussion of each stage. Then, we'll look at the entire process as it is done in an electronic contract manufacturing facility — Micree Corporation.

Fifth, the assembled board is visually inspected to determine if good component bonding has taken place. If problems are identified, rework may be required.

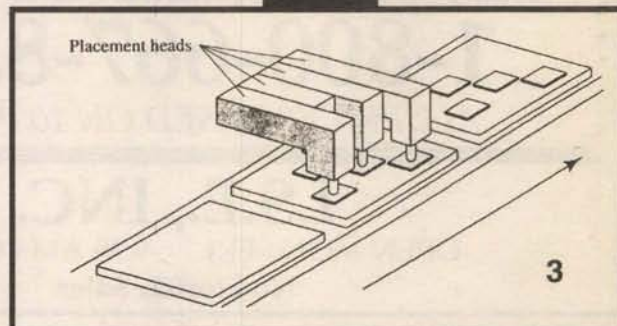
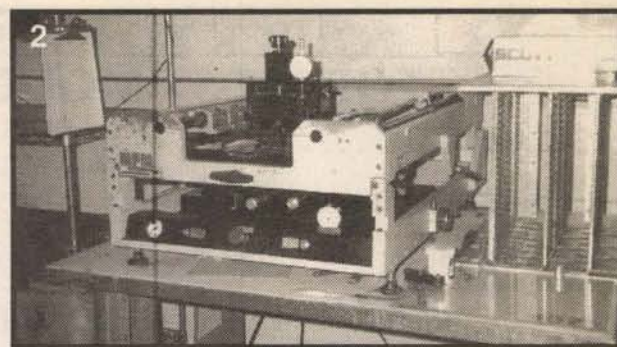
Sixth, the completed circuit is cleaned to rid it of flux residue.

The reflow soldering approach to SMT assembly just outlined offers numerous advantages, many of which we'll discover as we turn to a

Stage 1 — PC Board Inspection

Whether a company fabricates its own printed circuit boards or contracts their manufacture, out to a PC house, the boards must be carefully inspected prior to the application of solder paste in Stage 2. It is generally accepted that SMT PC boards demand closer scrutiny than boards designed for insertion mount technology (IMT). The smaller pads, the thinner traces, the emphasis on multilayers, and related factors combine to make close visual inspection under a magnifying glass a must.

The SMT inspector can take a "random check" approach, where spot checks at arbitrary locations are made, or concentrate on a particularly troubling area: extremely thin traces, for instance. Either way, one looks for physical defects in the board laminations, solder bridges, trace breaks, and for an even, smooth solder coat. If problems are identified, the board must be channeled to a rework station or rejected outright. If a bad board is allowed to



proceed to Stage 2, and beyond, the result can be prohibitively expensive and time-consuming, as whole circuit boards are resigned to the recycling heap.

State 2 — Application of Solder Paste

In Stage 2, solder paste is applied to printed circuit board pads. Solder paste is a mixture of tiny spherical solder particles, flux, and a carrier vehicle. When applied to the board's pads, it retains its sticky, "tacky" characteristic for many hours. This feature allows a surface mount component placed on the board to remain in position; no adhesive or glue is required to prevent the component from shifting around or falling off the PC board.

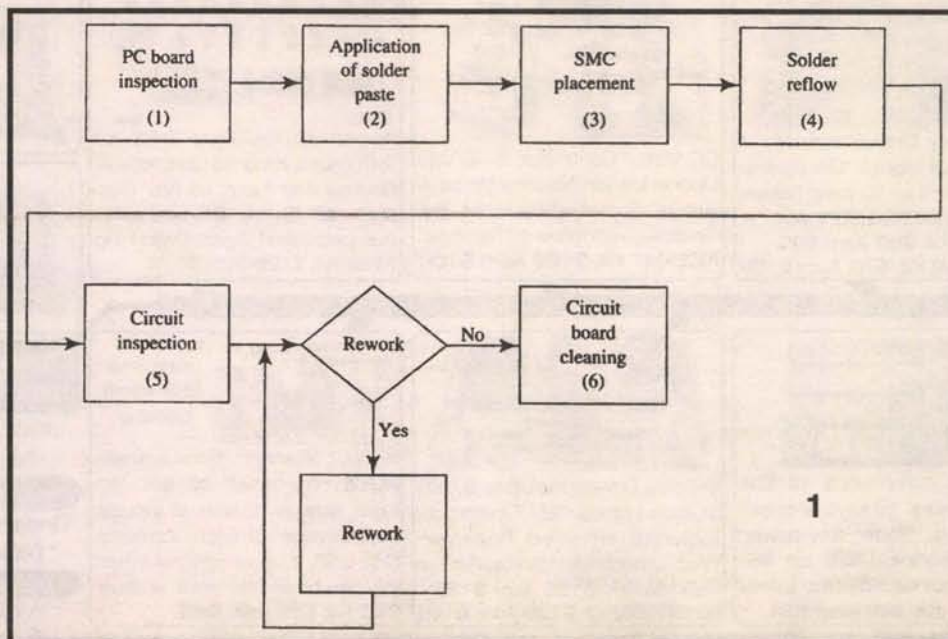
The paste is applied using a semiautomatic screen printer (Figure 2). An image of the PC board pads is first photographically "burned" into a stainless steel, fine-meshed "silk" screen held in a frame. As a result, open spaces on the screen are formed at each pad location. The rest of the screen remains opaque.

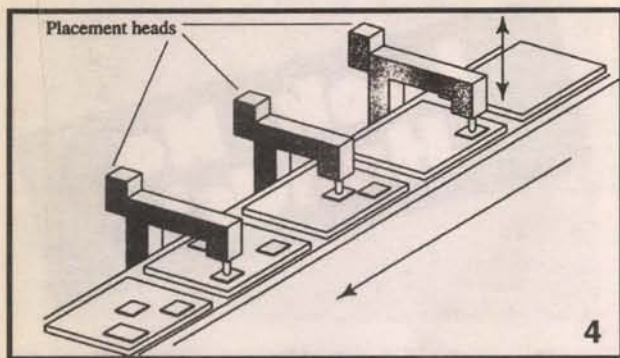
Next, solder paste is mixed and lightly spread over the screen. Then, the PC board is placed under the screen and carefully aligned. The paste is now "squeegeed" over the screen. As you would expect, solder paste is forced through openings in the screen onto the pads immediately below. The screen is next lifted and the PC board removed. Finally, a new printed circuit board is put in place and the whole process repeated. When a different circuit is to be assembled, its screen is inserted into the printer and a fresh board run is begun.

The process just described is not quite as straightforward and automatic as it might appear. There is considerable operator skill involved. As Jose Hernandez, technical manager at Micree Corporation, told me: "To produce a succession of well 'pasted' boards in a reasonably short time demands plenty of hands-on experience."

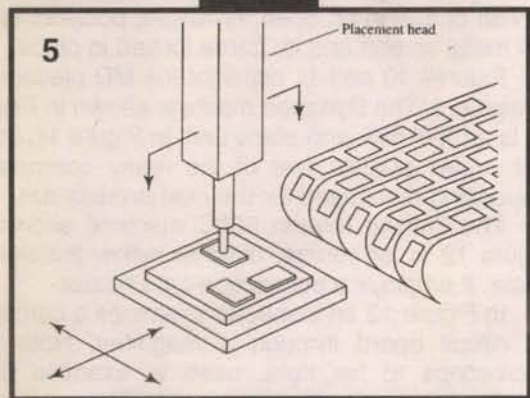
Stage 3 — Surface Mount Component Placement

Today's automatic pick-and-place equipment can install anywhere from 1,000 to 500,000 SMDs per hour. Whether it's toward the former or the latter depends on a number of factors, machine intelligence and the range of compo-

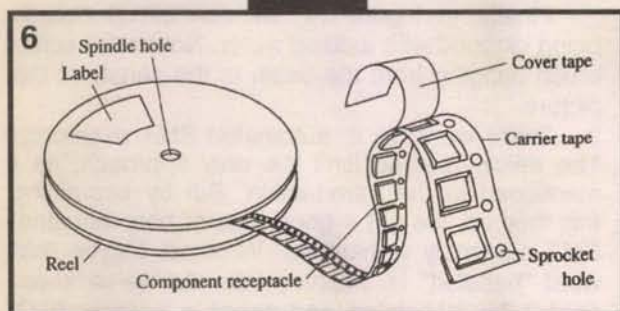




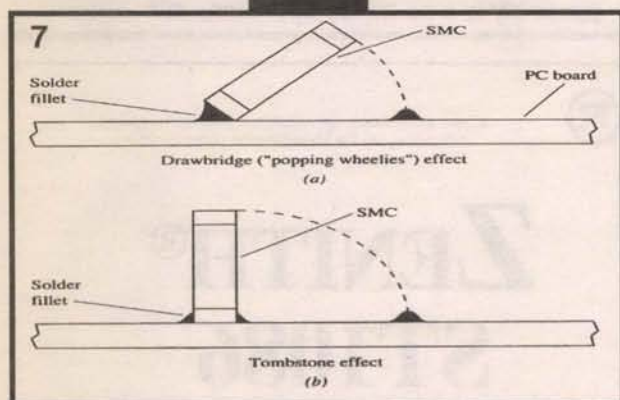
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nents that can be handled being the two most relevant. Prices for the units will vary considerably, from a low of \$20,000 to over \$1,000,000.

Three categories of placement equipment are in wide use. The huge, expensive mass placement machines place a whole batch of SMDs on a PC board at one time (Figure 3). Such machines require extensive programming and set-up time. They are ideal, however, for complex boards and extremely high production runs.

With in-line SMC placement machines, circuit boards pass under a series of placement heads, each of which places a single SMD on the board (Figure 4). When comparatively few SMDs are to be installed, this approach works well.

X-Y pick-and-place machines are the most popular choice for automatic SMD assembly. Such devices are essentially specialized computer-driven pick-and-place robots (Figure 5). In operation, a moving pick-and-place vacuum head fetches components one at a time and places them on the PC board. Components come from a dispensing reel, magazine, or bin dispenser.

The reel illustrated in Figure 6 is the most widely used component delivery method for X-Y pick-and-place machines. As you can see, hundreds of SMDs are stored in a plastic tape that is wound around the reel. As the plastic tape is fed to the

pick-and-place machine, the cover tape is automatically peeled away. The exposed SMDs are then picked up and put in place by the vacuum head. In operation, several reels, each with a particular component, are set in position to feed the X-Y pick-and-place machine.

Stage 4 — Solder Reflow

In Stage 4, the stuffed PC board, with its surface mount component terminals settled in their gray cushion of solder paste, moves slowly on a conveyor belt into the mouth of a waiting oven. Here the solder paste is melted (reflowed), solidifying the speck-size SMDs in place. The board is removed and allowed to cool. No one, you will have noticed, has lifted a component or a soldering iron. It sounds simple, and in theory it is. In truth, the solder reflow process is a bit more involved. It all depends on which of three heating methods are used.

The convection oven is the simplest, easiest, and least expensive way to reflow solder in an industrial setting. No wonder it's also the most popular method.

Basically, the convection oven is a forced-air heating system similar in concept to the heater that warms your house. The PC board sits in an oven, warm air is circulated, and the solder paste melts. That's it! No chemicals or complex processes are involved. About the only disadvantage to this approach is the need for critical temperature control.

In the infrared reflow soldering system, the solder paste is melted by infrared heat lamps. Because it is quick, the process works well for large circuit runs. Temperature control, however, is even more essential than with the convection oven.

Vapor phase reflow soldering represents a third way to reflow solder paste. Here, a dense blanket of vapor is created in the oven by boiling liquid fluorocarbons. The hot vapor condenses on the PC board with its SMDs and solder paste, causing the latter to melt. With this method, it is impossible to overheat the surface mount components. A major advantage. There is a down side, nonetheless. The fluorocarbons are very expensive, often costing hundreds of dollars per gallon. The oven, too, is quite costly. Some sell for over \$100,000.

Stage 5 — Circuit Inspection

After solder has been reflowed and allowed to solidify and cool in Stage 4, the printed circuit board is ready for circuit inspection. Given the small size of SMDs, they are always inspected under a magnifying glass.

The inspector looks first for the standard problems that appear with any PC board assembly: solder bridges, solder balls, trace breaks, and so forth. There are, however, two difficulties unique to SMT that require the inspector's singular attention.

When SMDs are reflow or flow soldered, they tend to exhibit what is known as the drawbridge effect or the tombstone effect (Figure 7). Both effects are evident when only one terminal of a two-terminal chip is actually soldered to the board. The other terminal has lifted completely off its pad.

In the drawbridge, or "popping wheelies," effect; the rise is less dramatic than in the tombstone effect, where the SMD assumes a vertical position. In both cases, however, the result is completely unacceptable — the chips are effectively out of the circuit.

Two phenomena cause drawbridging and tombstoning. Either an uneven quantity of solder paste is applied to a chip's pads, or the solder under one terminal melts before it does under the other. Attention to detail and operator skill during Stages 2, 3, and 4 minimizes these effects.



Stage 6 — Circuit Board Cleaning

If drawbridging, tombstoning, and related component misalignment occurs in Stage 5, circuit board rework will be required. Such rework can be fairly complex and involved.

The final stage in the reflow soldering process involves circuit board cleaning. Virtually all but the least expensive consumer electronics PC boards are washed of flux residue and other contaminants. Doing so results in better board appearance and less likelihood of circuit failure later on.

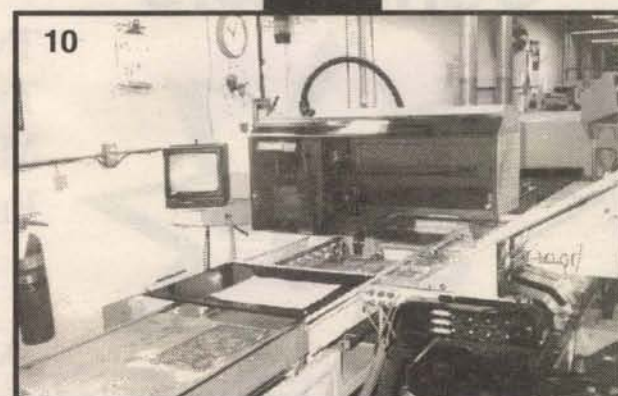
Two cleaning procedures are in wide use. One



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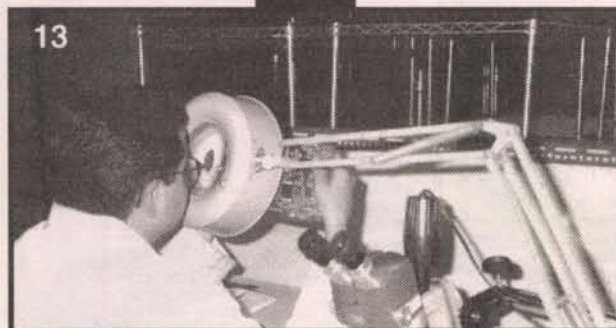


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is water-based (aqueous), the other uses organic solvents.

Do you know how your dishwasher works? Then you understand water-based cleaning. A hot spray of iodized water is directed, by hand or by machine, over the circuit board. A scrubbing action, again by hand or by machine, helps remove the flux residue. The PC board is then placed in a low-temperature oven to evaporate all water. The aqueous process is inexpensive and environmentally safe. Nonetheless, it is generally not as effective as solvent-based cleaning.

Solvent cleaners, when used in industry, are usually CFC (chlorofluorocarbon)-based. Such cleaners do a good job of removing contaminants, particularly rosin-based fluxes. CFCs, however, are



believed to be reducing ozone concentrations in the stratosphere. They are an environmental no-no. Fortunately, a natural solution to the depen-

dence on CFCs may be at hand. Are you ready for this? It has been claimed that ordinary lemon juice — that's right, good old acidic lemon juice — does as good a job of removing rosin fluxes as dangerous CFCs.

If that's true, it would be a win-win-win situation. The circuit manufacturers would be happy (lemon juice is relatively cheap), the environmentally conscious would rejoice, and, of course, the lemon growers wouldn't want to look a gift horse in the mouth. Oh, but if all our environmental/technological problems could be solved so easily!

The Reflow Process Illustrated

To study SMT assembly close up, I visited Micree Corporation, an electronic contract manufacturing facility located in Southern California. I spent a day with Jose Hernandez, Micree's technical manager. In addition to its traditional insertion mount technology assembly line, Micree has a complete SMT reflow soldering set-up, pictures of which are shown in Figures 8-14.

In Figure 8 we see blank circuit boards having just arrived from an outside vendor. After they are carefully unwrapped, they are visually inspected under a magnifying glass.

Figure 9 pictures Micree's semiautomatic screen printer in an open, or raised, position. Note the metal screen and its frame locked in place.

Figures 10 and 11 highlight the MD placement equipment. The Dynapert machine shown in Figure 10 is an X-Y pick-and-place unit. In Figure 11, Jose Hernandez adjusts one of the many component dispensing reels used for the next product run.

The TurbAir Infraflo 500C machine shown in Figure 12 is, of course, used to reflow the solder paste. It employs a convection-type heater.

In Figure 13 an inspector examines a completed circuit board through a magnifier. Note the microscope to his right, used to examine finer detail.

Finally, in Figure 14, we see circuit boards being cleaned with iodized water. Notice the scrub brush hanging from the basin in the center of the picture.

There we have it: automated SMT assembly! The reflow method isn't the only approach, as I mentioned in the introduction. But by examining this method, we get a good idea of how industrial SMT assembly is handled. Whoops! Maybe that word "handled" is inappropriate. As we've seen, except for inspection and possible rework, SMT assembly is a no-hands operation. **NV**

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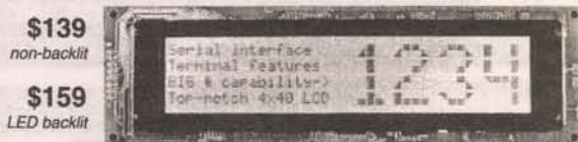
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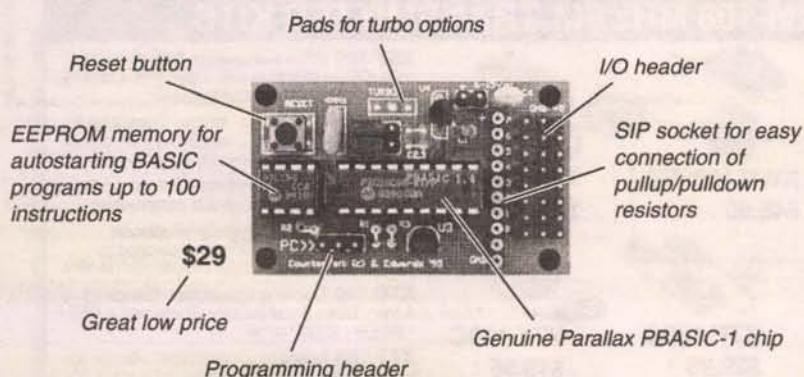


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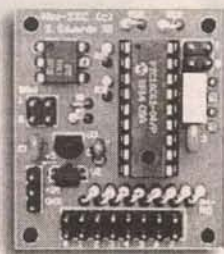
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Star 7 FSK Transmitter "RE-SPAWN"	129.95 - 109.95

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A/S - 90 Quick Kits	34.95 - 29.95
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PIO BA Writer	38.95 - 33.95
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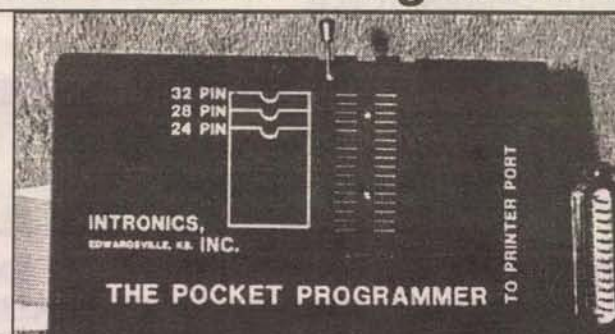
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PANASONIC	\$76	\$67
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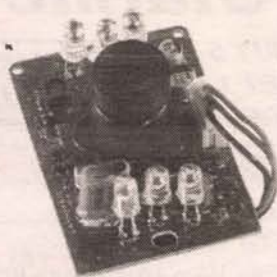
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Events CALENDAR

Continued from page 42

OH - MIDDLETOWN - Hamfest. SW Ohio Digital
Symposium. Hank Greeb 513-385-8363
PA - LEBANON - Computer Show. Lebanon Valley
Expo Center. MarketPro 301-984-0880 xt15
VA - RICHMOND - Computer Show. The Showplace.
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JANUARY 18-19

FL - MIAMI - Computer Show. Coconut Grove Conv.
Center. MarketPro 301-984-0880 xt15
OH - DAYTON - Computer Fair. Dayton Convention
Center. Trade Show Productions 513-263-3378
OH - DAYTON - Computer Show. Montgomery
County Fairgrounds. MarketPro 301-984-0880 xt15
VA - NORFOLK - Computer Show. Norfolk Scope.
MarketPro 301-984-0880 xt15

JANUARY 19

IL - GLEN ELLYN - Computer Show & Sale. College
of DuPage. Main Arena of Phys. Ed. Bldg. 9:30am-
3pm. Computer Central Shows 847-940-7547
MA - SWANSEA - Computer Show. Venus DeMilo.
9:30am-2:30pm. Northern Computer Shows
508-744-8440
MD - BOWIE - Computer Show. Bowie State
University. MarketPro 301-984-0880 xt15
NY - YONKERS - Electronic Flea Market. Lincoln
High School. Kneeland Ave. 9am-3pm. Otto
914-969-1053
OH - BROADWAY - Winter Ham Radio Fair. State
Hwy 347 W. of State Rt. 31. 8am-3pm. 937-246-5943
OH - NELSONVILLE - Hamfest. Sunday Creek AR
Federation. Allan Withem 614-767-2766

PA - DICKSON CITY - Computer Show. Ganetti
Manor. MarketPro 301-984-0880 xt15
VA - RICHMOND - Hamfest. Amateur Telecommuni-
cations Society. The Showplace, 3000 Mechanicsville
Tnpl. 8:30am-3:30pm. Craig Spain 804-526-9838

JANUARY 20

MD - TIMONUM - Computer Show. Maryland State
Fairgrounds. MarketPro 301-984-0880 xt15
OH - NILES - Computer Show. Eastwood Expo
Center. MarketPro 301-984-0880 xt15
VA - RICHMOND - Computer Show. The Showplace.
MarketPro 301-984-0880 xt15

JANUARY 25

IN - FT. WAYNE - Computer Show. Allen County
Fairgrounds. MarketPro 301-984-0880 xt15
IN - INDIANAPOLIS - AGI Computer Fair.
Indianapolis Events Center. 3655 E. Raymond St.
317-299-8827
MA - STURBRIDGE - Computer Show. Sturbridge
Host Hotel. 10am-3:30pm. Northern Computer
Shows 508-744-8440
MO - ST. CHARLES - Hamfest. St. Louis Repeater.
James E. Welby 314-353-2000
TN - GALLATIN - Hamfest & Computer Show.
Gallatin Civic Center off Hwy 31E. 8am-2pm. Bill
Ferrell 615-230-7923
VA - HARRISONBURG - Computer Show. Rocking-
ham Co. Fgnds. MarketPro 301-984-0880 xt15

JANUARY 25-26

FL - ORLANDO - Computer Show. Central FL
Fairgrounds, Bldg. B. MarketPro 301-984-0880 xt15
MD - GAITHERSBURG - Computer Show. Montgo-
mery Co. Fairgrounds. MarketPro 301-984-0880 xt15
OH - CINCINNATI - Computer Show. Cincinnati
Gardens. MarketPro 301-984-0880 xt15

JANUARY 26

CA - SANTA ANA - Swapmeet. ACP Parking Lot.
Mary Russo 714-558-8813
IL - VILLA PARK - Hamfest. WCRA. 630-545-9950
IN - FT. WAYNE - Computer Fair. Ramada Hotel, off
I-69 exit 105A. 10am-3pm. AGI Services
317-299-8827
IN - SOUTH BEND - Computer Show. Century
Center. MarketPro 301-984-0880 xt15
MD - ODENTON - Hamfest. Maryland Mobileers
ARC. Jim Botluk 410-280-9815
MI - MIDLAND - Computer Show. Holiday Inn. US-
10 @ Eastman Rd. Exit. Five Star Productions.
810-230-0988
NH - NASHUA - Computer Show. Sheraton Tara
Hotel. 10am-3:30pm. Northern Computer Shows
508-744-8440
OH - DOVER - Hamfest. Ohio National Guard
Armory. 2800 N. Wooster Ave. Howard Blind 330-
364-5258
PA - WILKES BARRE - Computer Show. Genetti's
Best Western. MarketPro 301-984-0880 xt15
VA - RICHMOND - Computer Show. VA Sports
Arena. MarketPro 301-984-0880 xt15

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Continued on page 106

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News

REED SWITCHES



GEM/Meder reed switches are glass encapsulated, hermetically sealed, and feature ruthenium and rhodium contacts, both sputtered or plated with pull-in sorting to ± 1 A/T. Ranging from 7.5 to 50 mm long and 1.8 to 5.6 mm diameter, they are available packaged as sensors, or individually can be cut, formed, and supplied with various lead length extensions.

GEM/Meder reed switches are priced according to size, quantity, and customer specifications.

For more information, contact:

GEM ELECTRONICS, INC.
160 FERNWOOD DR., DEPT. NV
EAST GREENWICH, RI 02818
401-885-8454 FAX: 401-885-1741

WWV BROADCAST RECEIVER



Hamtronics, Inc. announces a new low-cost dedicated receiver just for listening to the 10.000 MHz WWV broadcasts. The new model RWWV is a very sensitive and selective AM superhet receiver PCB module, crystal-controlled on 10 MHz.

The RWWV operates either on a 9-12 VDC power supply or a nine-volt battery (not supplied). It has a 50W input you can connect to any type of HF antenna. It is so sensi-

tive, you can even get good reception with just a small length of wire or an indoor whip antenna. The RWWV has a speaker amplifier and even a squelch circuit to mute the audio if the signal fades into the noise.

For more details, contact:

HAMTRONICS, INC.
65-N MOUL RD., DEPT. NV
HILTON, NY 14468-9535
716-392-9430 FAX: 716-392-9420

I²C™ SERIAL EEPROM DEVICES

Microchip Technology, Inc. introduces 1K-bit and 2K-bit serial EEPROMs designed specifically for embedded smart card applications.

The new devices, the 24C01SC and 24C02SC, are standard I²C memory devices with bondpad locations optimized for smart cards based on ISO standard 7816 requirements. The 24C01SC and 24C02SC are organized as a single block of 128 x 8-bits or 256 x 8-bits. These devices also have a page write capability of 8 bytes.

For more information, contact:

MICROCHIP TECHNOLOGY, INC.
2355 W. CHANDLER BLVD.
DEPT. NV
CHANDLER, AZ 85224-6199
602-786-7200 FAX: 602-899-9210

HUNTER RECEIVER & REMOTE



Street Smart Security is now shipping "Hunter," a six-channel programmable receiver and 15-channel long range remote. Each channel has programmable outputs of pulse, latch reset with condition, standard latch, 30, 60, or 90 second timed outputs.

Each channel can hold up to eight remotes giving you a possible total of 48 remotes on this receiver. The six low-voltage outputs can be used with alarm panels, garage doors, home automation, and electric door strikes.

For secure transmissions, each four-button remote uses a mathe-

matical algorithm to produce 70 billion randomly rotating codes. This is the same technology used by the FBI and Department of Justice. The four-button remote can control up to 15 channels on a micro sized remote.

The Hunter receiver is \$99.95 and each four-button remote is \$39.95.

For more information, contact:

STREET SMART SECURITY
7147 UNIVERSITY AVE.
DEPT. NV
LA MESA, CA 91941
1-800-908-4737
FAX: 619-462-0652
72704.1501@compuserve.com

TRVD-900



American Innovations, Inc. introduces the TRVD-900, their new state-of-the-art countersurveillance system. Powered by one nine-volt battery, this device will detect the presence of body-wires, tape recorders, transmitters, as well as video equipment. Upon detection, this system will either silently vibrate and/or alert the user with a visual confirmation.

The TRVD-900's special introductory price is \$495.00 and is available for immediate delivery.

For more information, contact:

AMERICAN INNOVATIONS, INC.
119 ROCKLAND CTR. STE. 315
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MIRAGE B-310-G



New Mirage B-310-G delivers 100 watts output with just 4 watts input. The Mirage B-310-G features a built-in low noise GaAsFET receive preamp that gives you 15 dB gain — lets you dig out weak signals. It has SWR protection and reverse polarity protection. It prevents damage from antennas whipping in the wind and can save your amp if you accidentally connect power backwards.

The suggested retail price is \$199.00 and comes with a full one-year warranty.

For more information, contact:

MIRAGE COMMUNICATIONS
921 LOUISVILLE RD., DEPT. NV
STARKVILLE, MS 39759
601-323-5869 FAX: 601-323-6551
<http://www.mirageamp.com>

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PASADENA, CA 91106
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New Products

MODULAR VACUUM MANIFOLDS



Vaccon segmented vacuum manifolds feature eight interchangeable venturi cartridges, sensors, and switches that can be configured to meet specific user requirements. Capable of cycle rates up to 1,920/minute, these modular compact venturi vacuum pump manifolds are highly dirt tolerant for handling a wide variety of materials.

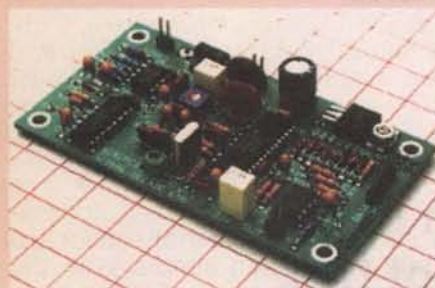
Providing precision blow-off control and rapid recovery, Vaccon segmented vacuum manifolds are available with up to 20 vacuum stations and different vacuum levels to 28" Hg and flow rates up to 3.4 cfm.

Vaccon segmented vacuum manifolds are priced at \$300.00 per segment regardless of configuration, sensor, and switch requirements.

For more information, contact:

VACCON COMPANY, INC.
32 REAR SPRING ST.
P.O. BOX 324, DEPT. NV
MEDFIELD, MA 02052
508-359-7200 FAX: 508-359-0177
E-MAIL: info@vaccon.com
<http://www.vaccon.com>

BOB-I



Decade Engineering announces a new character display peripheral for embedded microcomputer systems. BOB-I allows small microcontroller-based systems to display substantial amounts of text, as an overlay on composite video from standard NTSC cameras, or by generating a complete video signal on-board. The output signal from BOB-I can be distributed using low-cost CCTV technology for multiple (or giant) display applications, such as electronic signs. In many cases, BOB-I connects to an SBC or microcontroller with only one spare I/O pin (four maximum). Its video input circuit is differential, to reject low-

frequency common mode noise and prevent ground loop problems. Decade's BOB-I Developer's Package (\$200.00) includes convenient demo software (with C source code) that exercises BOB-I through the parallel port of your PC.

For further information, contact:

DECADE ENGINEERING
2302 5TH ST. N.E., DEPT. NV
SALEM, OR 97303-6832
503-363-5143 FAX: 503-399-9747
73054.1755@compuserve.com

TE-64D TONE ENCODER



Communications Specialists, Inc. introduces an upgraded version of their TE-64D tone encoder. The multi-purpose CTCSS/Burst tone unit now displays the actual tone frequency on a four-digit LED display. The self-contained, fully enclosed encoder provides all EIA CTCSS tones from 67.0 Hz to 203.5 Hz, plus all common burst tones from 1600 to 2550 Hz in 50 Hz increments. A front dial rotary switch provides tone selection, making it ideal for mobile applications, nighttime operations, or whenever high visibility readout is desired.

For further information, contact:

COMMUNICATIONS SPECIALISTS, INC.
426 W. TAFT AVE., DEPT. NV
ORANGE, CA 92865-4296
714-998-3021 FAX: 714-974-3420

SYNTHESIZED SIGNAL SOURCE



Novatech Instruments, Inc. introduces the Model 2955AR rubidium standard with synthesized output. The 2955AR has a direct digital synthesizer output that is 32 bit programmable from 10 Hz to 4 MHz. It also has fixed outputs of 10 MHz and 1 MHz.

The synthesized output has excellent spectral purity with typically less than -135 dBc phase noise at

1 KHz offset and long term stability equal to the rubidium atomic clock.

The 2955AR is ideal for use in communication system applications since it can be set to standard frequencies such as the 1.544 MHz T1 frequency. It can also be used as a master oscillator in laboratories and ground stations, as well as for test and calibration. The 2955AR is priced at \$4,295.00.

For further information, contact:

NOVATECH INSTRUMENTS, INC.
1530 EASTLAKE AVE. E.
STE. 303, DEPT. NV
SEATTLE, WA 98102
206-322-1562 FAX: 206-328-6904
<http://www.eskimo.com/~ntsales>
E-MAIL: novatech@eskimo.com

HAKKO 808 DESOLDERING TOOL



Jensen Tools Inc. offers a truly portable desoldering tool for field work. Made by Hakko, the 808 desoldering tool is completely self-contained with a built-in vacuum pump. It achieves efficient results with an adjustable temperature control and simple tool maintenance. The miniature double-cylinder diaphragm pump is designed to minimize vibration and maximize solder removal.

For more information, contact:

JENSEN TOOLS, INC.
7815 S. 46TH ST., DEPT. NV
PHOENIX, AZ 85044-5399
602-968-6241 FAX: 602-438-1690

NEW 6.4 mm Ø OEM LASER MODULES



NVG, Inc. introduces the smallest production laser module. Only

6.4 mm (0.252") Ø x 17.5 mm (0.689"). Its space-saving size and wide range of wavelengths at or below 5 mW output power makes the 6.4 series OEM laser modules a must for miniature alignment systems, bar code readers, pointers, aiming devices, or wherever a sub-miniature laser is a must. Each 6.4 series module has an integral high-efficiency SMD automatic power control circuit for stable operation, laser diode, collimating tube, and adjustable glass gradient index lens for superior beam quality over industry standard lasers.

For more information, contact:

NIGHT VISION OF GEORGIA, INC.
RT. 1 BOX 1680, DEPT. NV
HAZLEHURST, GA 31539
912-379-0608 FAX: 912-375-9555

LOW-COST ACCELEROMETER

CFX announces a low-cost accelerometer family designed for use in data acquisition systems, automotive testing, earthquake monitors, and robotics.

Models based on micromachined technology are available in single and triaxial configurations with prices starting as low as \$85.00.

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VANGUARD SOFTWARE CORP.
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CARY, NC 27511
919-859-4101 FAX: 919-851-9457
<http://www.vanguardsw.com>

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#TM-169 \$10⁰⁰ each
6/\$50.00

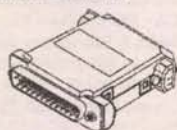
Centronics Adaptors

DB25 male to 36 pin female Centronics

#CA-180

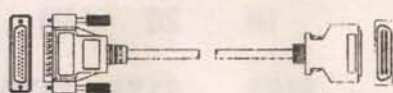
\$2⁰⁰ each

20/\$1.60 each
50/\$1.20 each



I-EEE-1284 Printer Cable

10' Bi- Directional
DB25 Male to Mini Centronic 36
A.K.A type "A" - "C"



#CC-PR6-BIMIN

\$5⁰⁰ each

20/\$3.00 each

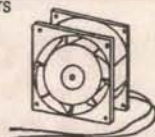
12v DC Fan

3 1/8" x 1" Ball Bearing type
Standard replacement fan for
PC/AT mini-tall towers

#TM-FAN

\$4⁰⁰ each

20/\$3.50 each



Mini Stereo Extension

6ft. 3.5 mm male-female



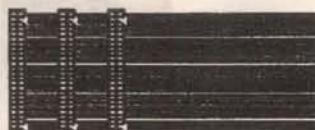
#AC-559

\$1⁰⁰ each

50 & up .75¢

SCSI Cable

36" 50 pin 2 device



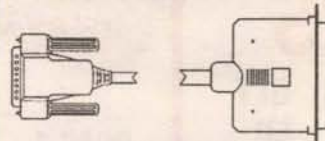
#CC-344

\$3⁰⁰ each

20/\$2.60 each 50/\$2.30

SCSI Cable

IBM or MAC Controller to device
DB25 to 50 pin Centronics male to male



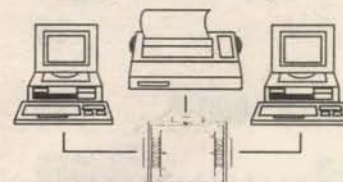
#CC-669

3 foot \$3⁰⁰ each

20/\$1.75 each

2 Computers to 1 Parallel Printer

Manual/Auto Switch • Easy to install and operate
All DB25 female connections
Power jack available for long cables



#DS-201P w/Time-out switch \$10⁰⁰ each

TV/VCR Cables Quick connect "F" to "F"

Heavy duty 24K gold connectors
Double shielded
Double insulated
Clear jacket
Limited Quantity!
Professional quality



6 Foot #VC-6FF-QG

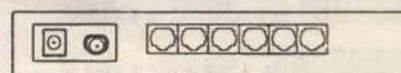
\$1⁰⁰ each

10 Base-T Hub

6 RJ-45 Ports BNC Input

I-EEE 802.3 Specification

MFG. By National Semiconductor



#TM-TBT-HUB6 \$69⁰⁰ each

Computer Power Center

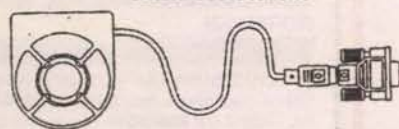
Five outlet-Surge Protected
Phone/Fax/Modem
3 M.O.V. protection model
EMI /RFI filters
U.L. & CSA listed
Ultra slim housing
Computer beige color
15 amp circuit breaker
Heavy duty 14/3 cord



#TM-201

\$22⁰⁰ each 5/\$19.50each

Mini Trackball



3-Button operation, 3.5" driver disk, users manual
400 DPI - 1600 DPI resolution
Perfect for laptops or desktops
Serial adaptor from 6 pin to DB9 included

#TM-291-MINI

\$6⁰⁰ each

Grey Color

Automatic Wire Stripper

Crimper and Wire Cutter
Steel Construction

Automatically
adjusts to wire size
Strips 10 to 26 gauge

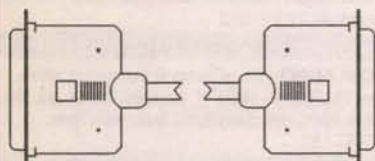
#TM-NIC-1

\$5⁰⁰ each



SCSI 1 to SCSI 1 Cable

50 pin Centronics male to male

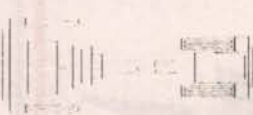


#CC-676-E

6 foot \$3⁰⁰ each 20/\$2.00

AT Modem Cable

DB25 male to DB9 Female



9 foot #CC-906 \$2⁵⁰ each

20/\$2.00 50/\$1.65

10' Bi-Directional Printer cable

DB25 male to standard 36 centronics



Cable for HP Laser
and others meets
1284-IEEE standards

#CC-PRI-1284 \$10⁰⁰ each

Mini Mouse

2-Buttons operation
perfect for laptops
compact design

DB9 connector for any serial port
3-5" serial mouse driver disk
Instruction manual



#TM-290-Mini

\$6⁰⁰ each

Black color

Heat Sink with Fan - New Low Price!

Easy power hook-up! Works with ZIF Socket. Clips to Chip.

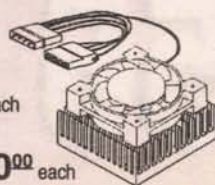
Sleeve Bearing

#TM-FAN-2 486 CPU \$5⁰⁰ each

#TM-FAN-90 Pentium CPU, 75-150 MHz \$6⁰⁰ each

Ball Bearing

#TM-FAN-90BB Pentium CPU, 75-150 MHz \$10⁰⁰ each



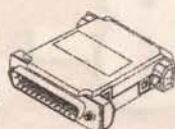
DB25 Null Modem Adaptor

for serial printer and plotters
male to female

#CA-134

\$2⁰⁰ each

20/\$1.60 50/\$1.40



10 Base-T Cables

Category 5

\$2⁵⁰ 3ft #TE-038-L5

\$3⁰⁰ 7 ft #TE-068-L5

\$4⁰⁰ 14 ft #TE-128-L5

\$6⁰⁰ 25 ft #TE-258-L5

\$12⁰⁰ 50 ft #TE-508-L5

\$20⁰⁰ 100 ft #TE-108-L5



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TNT-3	\$55	\$50	\$45
STEALTH 80P	\$45	\$39	\$35
M80-3	\$55	\$50	\$45
PIO-3+	\$59	\$55	\$50

NEW CONVERTERS

	QTY 10	QTY 20	QTY 50
CENTURY CT-3000 ...	\$65	\$60	\$55
PANASONIC 145	\$79	\$74	\$69

NOVAVISIONS

	QTY 10	QTY 20	QTY 50
NV-5600 (PIO)	\$199	\$185	\$170
NV-5700	\$199	\$185	\$170
NV-5800	\$199	\$185	\$170
NV-5750 (JBB) ...	\$275	\$260	\$245

BOSS COMBOS

	QTY 10	QTY 20	QTY 50
BOSS 1	\$195	\$185	CALL
BOSS 2	\$195	\$185	CALL
BOSS 3	\$195	\$185	CALL

CALL FOR THIS MONTH'S SPECIALS

1-800-808-3356

DIRECT CABLE SUPPLY

Events CALENDAR

Continued from page 100

JANUARY 28

MD - ODENTON - Swapfest. Odenton Vol. Fire Dept. Hall, 1425 Annapolis Rd. 8am-2pm. Bill Ziegler 410-987-2384

FEBRUARY 1997

FEBRUARY 1

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in 619-561-0052
MA - HYANNIS - Computer Show. Tara Cape Codder Hotel. 10am-3:30pm. Northern Computer Shows 508-744-8440

TX - AMARILLO - Hamfest. Potter Cty. ARES. Ben Pollard 806-381-8810

FEBRUARY 1-2

FL - MIAMI - Tropical Hamboree. Dade Radio Club. Youth Fair & Exposition Center. 10901 SW 24th St. Sat. 9am-5pm. Sun. 9am-4pm. 305-642-4139

MD - NEW CAROLLTON - Computer Show. Ramada Conference & Exhibition Center. MarketPro 301-984-0880 xt15

MD - PIKESVILLE - Computer Show. Pikesville Armory. MarketPro 301-984-0880 xt15

MO - ST. CHARLES - Computer Show. St. Charles Exposition Hall. St. Charles Ctr. I-70 & 5th St. Sat. 10am-4pm. Sun. 11am-3pm. Computer Central Shows 888-296-6066

OH - COLUMBUS - Computer Show. Ohio Exposition Center. MarketPro 301-984-0880 xt15

FEBRUARY 2

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857

MA - BRAINTREE - Computer Show. Sheraton Tara Hotel. 10am-3:30pm. Northern Computer Shows 508-744-8440

FEBRUARY 8

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

MI - BLAINE - Midwinter Madness. National Sports Center, Exit #32 off 35 W. N. of Minneapolis/St. Paul. 8am-3pm. RARC 612-537-1722

SC - CHARLESTON - Hamfest & Computer Show. Stall H.S. in N. Charleston. I-26 & Ashley Phosphate Rd. Northwoods Mall, Waccamaw. Jenny Myers 803-747-2324

FEBRUARY 8-9

FL - JACKSONVILLE - Computer Show. Morocco Shrine Auditorium. MarketPro 301-984-0880 xt15

PA - KING OF PRUSSIA - Computer Show. Valley Forge Convention Ctr. MarketPro 301-984-0880 xt15

VA - CHANTILLY - Computer Show. Capital Expo Center. MarketPro 301-984-0880 xt15

WV - CHARLESTON - Computer Show. Convention Center. MarketPro 301-984-0880 xt15

FEBRUARY 9

OH - MANSFIELD - Hamfest & Computer Show. Richland Co. Fgnds. 7am. Pat Ackerman N8YOB. 419-589-7133

PA - LATROBE - Hamfest. Chestnut Ridge ARC. Bill Demosky 412-539-1552

FEBRUARY 14-15-16

FL - ORLANDO - HamCation & Computer Show. Central FL Fgnds., 4603 W. Colonial Dr. St. Rd. 50. Fri. 5pm-9pm, Sat. 9am-5pm, Sun. 9am-3pm. 407-823-7133

FEBRUARY 15

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in 619-561-0052
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 317-299-8827

MD - BALTIMORE - Computer Show. Martin's West. MarketPro 301-984-0880 xt15

NH - SEABROOK - Computer Show. Greyhound Park. 10am-3:30pm. Northern Computer Shows 508-744-8440

PA - OBERLIN - Winter Hamfest. Oberlin Fire Co. 8am-12pm. HRAC AnswerLine 717-232-6087

VA - ANNANDALE - Computer Show. Northern VA Comm. College. MarketPro 301-984-0880 xt15

FEBRUARY 15-16

GA - NORCROSS - Computer Show. North Atlanta Trade Center. MarketPro 301-984-0880 xt15

PA - MONROEVILLE - Computer Show. Pittsburgh Expo Mart. MarketPro 301-984-0880 xt15

FEBRUARY 16

IL - ROCK ISLAND - Hamfest. QCCA Expo Center, 2621 4th Ave. Davenport RAC. Kent Williams K9UQI 309-796-0718 4-9pm only

IN - NOBLESVILLE - Computer Fair. Hamilton Co.

Continued on page 109

Don Lancaster's

RESOURCE BIN

number fifty nine

Starting your own tech venture.

Our usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referrals and off-the-wall networking on nearly any electronic, *tinaja* questing, personal publishing, money machine, or computer topic by calling me at (520) 428-4073 weekdays 8-5 Mountain Standard Time.

I'm now in the process of setting up my new *Guru's Lair* web site you will find at (where else?) www.tinaja.com. This is the place you go for instant tech answers. Among the many files in our library, you will find complete reprint sets for all of the *Resource Bin* and other columns.

You will get the best results if you have both *Netscape Gold* and *Acrobat Reader 3.0*. You download these from www.netscape.com or www.adobe.com.

Your Own Technical Venture

There are lots of good reasons for starting up your own smaller scale tech or craft venture. Because you are up to something you'd like to make a buck out of. As a shell to be expanded if anything bad ever happens to your real job. As some independent route towards doing your things your way. As a goal to be filled. To provide an essential needed service. To promote something you believe in.

One of the biggest reasons is that your own personal tech venture gives you the credibility you will need to be treated seriously by others. On your own terms.

Some Essentials

I like to call all these individual and smaller scale technical ventures *Secret Money Machines*. For your own secret money machine to work, you'll first have to be into a technical or craft trip on a total lifestyle basis. Second, you must want to stay in control. Third, all your income goals should be just barely enough to keep you going. And fourth, you have to be gentle.

It should go without saying that such frivolities as food, clothing, or shelter will have to be set aside if

you are at all serious about this. And that *any* fixed expenses are a no-no.

What is surprising is that many of the things that urban lore "knows" are essential for a business are unneeded, or counterproductive, or ultimately downright destructive.

For instance, a new money machine *must* studiously go out of their way to *avoid*: All adequate advance financing, solid patent protection, practicing the business of business, strong legal and financial advice, heavy use of other people's money, superb high-traffic locations, strict employee security, very aggressive marketing, total new product secrecy, or mission-oriented creative management.

Getting sucked into so much as *one* of these ratholes is *guaranteed* to make your money machine fail.

Strategy and Tactics

Several core money machine rules which appear to work for me

NEXT TIME: Don tells us all about his favorite world wide web sites.

include: Having as many different sources of income as you can; always seeking out complimentary sources of income; aiming towards royalties or similarly deferred income; including as much personal value as possible; getting and staying in control of information flow; placing nothing between you and all your customers; using associates, not employees; avoiding start-up front money, for it surely will be blown on the wrong things at the wrong time, leading you to even higher future expenses; recognizing that total cash flow is everything; aiming for a minimum of a 200% return on front-end expenses; giving them something extra; and, of course, leaving them wanting more.

Tactics are lesser secrets that make your money machine more effective. Including: knowing the differences between megabucks, j-dol-

lars, and cold cash; separating frugality from stupidity; identifying all of your blind spots; avoiding granfalons; using the black widow effect; avoiding psychic energy sinks; suppressing ego; letting others pay you for your fun.

Getting Started

To start a tech venture, you simply get up one morning and tell yourself you are in business. Next, you go and register your new company as a trade name. Your rules differ from state to state, but you do something like this: You call the Secretary of State's office and then inform them that you want to register a trade name. They send you some forms. Obviously, the name isn't allowed to be in use, misleading, or obscene. Then they'll charge you some fee. Such as \$25.00 in Arizona. You also should get a state tax stamp.

And, if needed, a city one.

Next, you'll tell the Post Office you will accept mail for the new name. A Post Office box is also usually a good idea if you don't already have one.

But you do *not* tell the city zoning folks or the phone company that you have a business. Nor do you tell your bank you are now a business. Instead, you just find the "alias card" for your checking account and quietly add the new name to it. Finally, get yourself a "for deposit only to the account of ..." big rubber stamp.

Naturally, you should start keeping accurate records. Ones that use strict *dollars-in* and *dollars-out* full cash flow accounting. The IRS allows business deductions in anything professionally conducted in which there appears to be a genuine intent to make a profit.

You're also supposed to actually make a profit two years out of five.

Deductions for home business have been a sticky point with the IRS, but the rules are easing. If your work area at home gets clearly and exclusively used *strictly* for business, then a full deduction can be justified.

Also easing is picking up *VISA* and *MasterCard* merchant status for TO (telephone order) or MO (mail order) transactions. A few years back, it was just about impossible to get yourself a Merchant account. These days, you can do it if you shop around.

Switch to answering your phone in a professional manner. I often answer mine as 4073. Besides sounding like some extension in a megacorporation, this causes any cold sale caller to lose his place in their script.

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LaserWriter Reference	\$19.50
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Acrobat Reference	\$24.50
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RESOURCE BIN

SOME TECH VENTURE START-UP RESOURCES

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Scott Edwards 964 Cactus Wren Lane Sierra Vista AZ 85635 (520) 459-4802	Microchip Technology 2355 W Chandler Blvd Chandler AZ 85224 (602) 786-7200	Paper Access 23 West 18 St New York NY 10011 (800) PAPER-01	Premier Papers PO Box 64785 St Paul MN 55164 (800) 843-0414	Target Marketing 401 N Broad St Philadelphia PA 19108 (215) 238-5300
Fire Engineering PO Box 1289 Tulsa OK 74101 (918) 835-3161	Midnight Engineering 1700 Washington Ave Rocky Ford CO 81067 (719) 254-4558	Paper Direct 57 Romanelli Ave S Hackensack NJ 07606 (800) A-PAPERS	Powder/Bulk Solids PO Box 640 Morris Plains NJ 07950 (201) 292-5100	Technique 10 Post Office Sq #600S Boston MA 02109 (800) A-PAPERS
Great Papers PO Box 8465 Mankato MN 56002 (800) 287-8163	Nuts & Volts 430 Princesland Ct Corona CA 91719 (909) 371-8497	Paper Plus 300 Oceangate #800 Long Beach CA 90802 (213) 436-8291	Standard Rate & Data 3004 Glenview Rd Wilmetts IL 60091 (800) 323-4588	Ulrich's Dictionary 121 Channon Rd New Providence NJ 07974 (908) 771-7714

Also, of course, you *immediately* get yourself an Internet account through a local ISP, followed up by registering your own fully professional looking web home page.

The final key is to get yourself some letterheads and business cards. Using your own PostScript speaking printer is ideal for this sort of thing. You only print what you need as you need it.

While ordinary fancy papers from *Paper Plus* can be used, attractive laser compatible letterhead blanks are sold by *Great Papers*, *Paper Access*, *On Paper*, *Paper Direct*, *Premier Papers*, and those folks at *Technique*.

Uh, I guess we could go on like this for an entire book. As you might have figured out, the book is *The Incredible Secret Money Machine II* and is found in my nearby *Synergetics* blurb. Let us instead fast forward to ...

Advertising and Promotion

We'll start off with the *wrong* way. You find a glossy computer mag and buy a one month ad for \$8000.00, from which you might get 83 inquiries that will cost you several hundred dollars to respond to. Mostly because you've spent too much on your outsourced print catalogs. And in just a few short months, these 83 inquiries generate a stunning total of *seven* sales.

One sale is to a reverse engineering competitor. One sale will be the COD that bounces after another six weeks, whose returned contents have gotten trashed by a speed-crazed Doberman.

One sale is a bad VISA.

One sale is foreign, whose red tape, hassles, handholding, and exchange rate mix-ups cost you three times what it was worth. One went to a prison and got refused by the warden.

One sale vanished without a trace in a misnumbered apartment. And your final sale demanded a refund.

Or, as just happened to me: You *United Parcel Service* a package that gets properly delivered to a Michigan doorstep. The postal deliv-

ery epsilon minus sees the package, notes there is no US postage on it, and then *returns it to Thatcher* via the Post Office.

Direct mail promotion can similarly become a total disaster. Long ago, one "campaign" of mine ended up paying buyers several dollars each to haul the books being sold away. *If* you have an exceptionally well done offer made in a timely manner sent to a *very* tightly targeted audience, then *sometimes* you *might* reach as much as a *two percent* response from direct mail.

If you really want to follow these routes, more on traditional ad prices and such are found in *Standard Rate & Data*, *Targeted Marketing*, or *Direct*.

Let us instead go back to three first principles of start-up promotion: *By far your best advertising is through word of mouth*, from satisfied customers.

More importantly: *If you can't sell a few products to your friends, there is no way you will sell bunches of them to your enemies*. And finally: *Always test before you commit. Then test again*.

Initially test your products through *local* sales. At computer fairs. Or at swap meets. Or club demonstrations. Or on consignment, working closely with a *nearby* computer store.

Nuts & Volts is one of the very few sources where you can place low-cost classified ads to test the marketability of your product at reasonable costs. In general, a single ad might only have a limited pull. Repeating the ad three or more times usually greatly increases the interest and response.

My five essential *Synergetics* promo tools include the *advertorial*, *editorial exchange*, a *self-published brochure*, the *review*, and the *web site*.

An *advertorial* is any technical article written for a special interest magazine or a trade journal. While purportedly offering genuinely useful content that stands alone, a well done advertorial leaves a reader with an uncontrollable urge to whip out their VISA card.

With an *editorial exchange*, you

will accept a "complimentary" ad as *partial* payment for tech content that you've provided to some magazine or trade journal. This can be a good deal for both writer and publisher. But *never* trade out even.

More on advertorials and editorial exchanges in *ADVETORIAL.PDF*. The *self-published brochure* is just that. Printed (and auto-addressed) as needed on a demand basis. Lots more details in *ACROCAT.PDF*.

Product reviews can end up useful when you do not expect too much from them. Typical magazines are continually looking for fresh content in their new products sections or review columns. I have gotten best results when staying tightly targeted, and contacting *known people*.

More in *REV1001.PDF*

Yeah, "net" is short for *not entirely true*. But we are rapidly approaching the time where *"if it ain't on the net, it flat out don't exist."*

The net turns marketing and sales totally inside out. You can instantly reach thousands of customers at the click of a mouse. Cheaply.

Your own commercial web site is an *absolute must*. But this only works when you offer genuinely useful sole sourced content and well annotated gateway links and give lots away to sell little. "Demand pull" is the *only* type of advertising that works.

Web site registration is done online through *Internic*. More on web sites in *NUTS55.PDF*, in *NUTS56.PDF*, and in *WEAVEWEB.PDF*.

Getting Ideas

Once long ago and far away, ideas were worth a dime a dozen. But these days, ideas are now worth less than 10 cents a bale in 10 bale lots.

Because of what is known as the *idea mortality curve*, not one scheme in 1,500 ever generates a net positive cash flow. Thus, most of your time should be aimed at *ruthlessly stomping out bad ideas* that won't make the final cut.

The key secret to having one or two great ideas is to come up with several thousand lousy ones.

As always, the rules of *find a need and fill it and find a parade and get in front of it* all apply in spades.

At any rate, my own "primary idea generator" involves quite aggressive subscribing to free trade journals and other selected magazines. Everything from *Powder and Bulk Solids* to *Fire Engineering* to *WET — The Magazine of Gourmet Bathing*. Over five hundred at my last count.

Ulrich's Periodicals Dictionary has the keys to the kingdom, and is *by far* your single most important resource.

Be sure to check this one out.

A second source for ideas is your ongoing questions to me on my tech helpline and via E-Mail. A third source is all the *tinaja* questing contests. A fourth source is simply mulling things over on long bicycle trips.

Your final and most important idea sources are *amplifiers with nothing to amplify*. Stuff that's just gotta be done. Just because it's there. Or could be there. And just because you want to do it. Just because.

More on my primary research tools in *PRIMREST.PDF*

Some Starters

If I have to tell you what ideas you are going to need for your new tech venture, then that venture is doomed to failure. Guaranteed.

But let's briefly review the obvious emerging hot areas today: *Navicubes*, *Book-on-demand Publishing*, *Santa Claus Machines*, *Magic Sinewaves*, *Community Typesetting*, *Custom Laser Products*.

Flutterwumpers, *Wavelets*, *PostScript as Language*, *Web Mastering*, *Desktop Finishing*, *Dildonics*, *Nonlinear Video*, *Aerogels*, *Water Knives*, *Direct Toner Printed Circuits*, *Magnetic Refrigeration*, *GPS*, and *Brain Parity*.

And, well, maybe just one stunning new opportunity: You already know that the *BASIC Stamp* from *Parallax* and the *Scott Edwards PIC Tools* can open whole new worlds for you.

But I believe in *elegant simplicity*. I loathe to see any bloated computer system as horrendously complex and as overblown as a *BASIC Stamp* end up as gross overkill for those *really* low-end applications. Places where smarts have never dared go before.

And places wherein incredible new opportunities lie.

For this goal, *Microchip*

Technology has come out with their new 12C508 microcomputer. An entire computer costing under a dollar and requiring zero external support. In an eight-pin miniDIP package. And up to seven of those pins can be input/output.

Three to five volt supply, using as little as 15 microamps of current.

Much more on exploiting this gem in MUSE108.PDF

For More Information

Midnight Engineering is one great bimonthly magazine on starting and running your own smaller scale tech venture. They also put on conferences and clan gatherings.

Yeah, I've got a column there. I've also got my *Blatant Opportunist* bound reprint volumes. My *Incredible Secret Money Machine II* is one useful start-up guide. An intro and sample chapter appears on the ISMM library shelf of www.tinaja.com as ISMMINTR.PDF.

This Month's Contest

Let's have us three wildly different contests this month. You can: (A) tell me a story involving your own money machine; (B) write me a multitasking UNIX kernel for the 12C508, or even harder; (C) find me a clean late model VW Synchro, with a differential lock, but non-Westly.

There will be a largish pile of my new *Incredible Secret Money Machine II* books going to the dozen or so better entries, plus an all-expense-paid (FOB Thatcher, AZ) tinaja quest for two that will go to the very best of all.

Send all your written entries to me here at Synergetics, rather than to Nuts & Volts editorial. NV

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Events CALENDAR

Continued from page 106

Fairgrounds, off I-37 exit Pleasant Rd. near Walmart.
10am-3pm. AGI Services 317-299-8827

MA - TAUNTON - Computer Show. Taunton Holiday Inn. 10am-3:30pm. Northern Computer Shows 508-744-8440

MD - BOWIE - Computer Show. Bowie State University. MarketPro 301-984-0880 xt15

NC - ELKIN - Hamfest. Briarpatch ARC & Foothills ARC. Jimmy Holbrook 910-957-3820

NY - FREEPORT - Hamfest. Long Island Mobile ARC. Mark Nadel 516-796-2366

PA - LANCASTER - Computer Show. Holiday Inn Lancaster Host. MarketPro 301-984-0880 xt15

FEBRUARY 17

MA - BOXBOROUGH - Computer Show. Holiday Inn. 10am-3:30pm. Northern Computer Shows 508-744-8440

OH - NILES - Computer Show. Eastwood Expo

Center. MarketPro 301-984-0880 xt15

PA - ALLENTOWN - Computer Show. Allentown Fairgrounds. MarketPro 301-984-0880 xt15

VA - RICHMOND - Computer Show. The Showplace. MarketPro 301-984-0884 xt15

FEBRUARY 22

AR - RUSSELLVILLE - Hamfest. AR River Valley. Dallas Scott 501-967-3317

FL - SPRING HILL - Hamfest. Hernando County ARA. Lee Kent 352-799-1638

GA - DALTON - Hamfest. Dalton ARC. Harold Jones 706-673-2291

IN - LAPORTE - Hamfest. LaPorte Civic Center. 8am-2pm. John N9ROH, POB 30, LaPorte, IN 46352

NH - MANCHESTER - Computer Show. Center of NH Complex. 10am-3:30pm. Northern Computer Shows 508-744-8440

NJ - TRENTON - Computer Show. Trenton State. MarketPro 301-984-0880 xt15

TX - ORANGE - Hamfest. Orange ARC. Irene

Thomas 409-745-3061

VT - MILTON - Hamfest. Radio Amateurs of Northern Vermont. Mitch Stern 802-879-6589

FEBRUARY 22-23

FL - TAMPA - Computer Show. FL State Fairgrounds. MarketPro 301-984-0880 xt15

MD - GAITHERSBURG - Computer Show. Montgomery County Fairgrounds. MarketPro 301-984-0880 xt15

OH - CINCINNATI - Hamfest. Great Lakes Division Convention. Stanley Cohen 513-531-1011

OH - DAYTON - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880 xt15

TN - KNOXVILLE - Computer Show. Knoxville Fairgrounds. MarketPro 301-984-0880 xt15

FEBRUARY 23

DE - NEWARK - Computer Show. University of DE. MarketPro 301-984-0880

IL - GLEN ELLYN - Computer Show & Sale. College of DuPage. Main Arena of Phys Ed Bldg. Corner of Park Blvd. & College Rd. Computer Central Shows 847-940-7547

ME - PORTLAND - Computer Show. Verillo's Conv. Center. 10am-3:30pm. Northern Computer Shows. 508-744-8440

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Microcomputer pioneer and guru Don Lancaster is the author of 33 books and countless tech articles. Don maintains his no-charge US tech helpline found at (520) 428-4073, besides offering all of his own books, reprints, and consulting services. Don also has two free catalogs full of his resource secrets waiting for you. Your best calling times are 8-5 on weekdays, Mountain Standard Time.

Don is in the process of setting up his Guru's Lair at <http://www.tinaja.com>

Full reprints and preprints of all Don's columns and ongoing tech support appear here. You can reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to his US Internet address of don@tinaja.com

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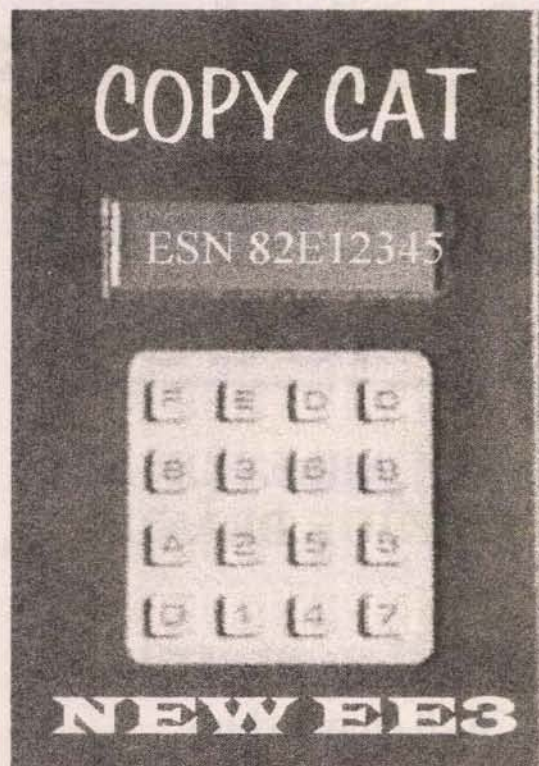
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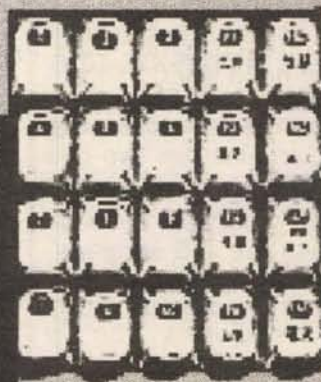


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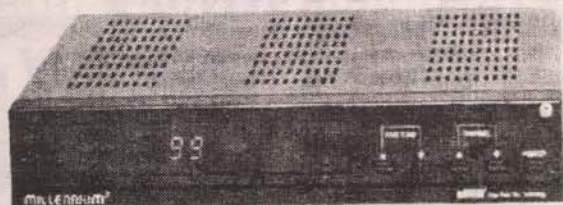
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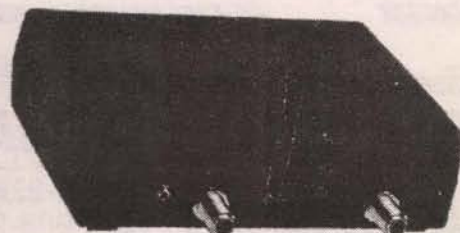
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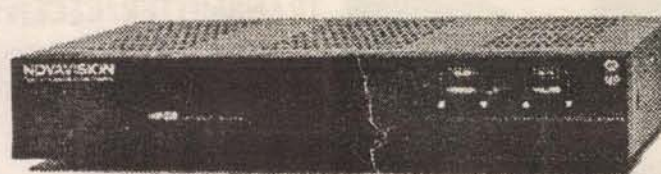


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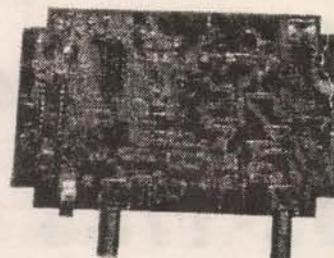
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reader FeedBack

Continued from page 6

whatever.

I wish to express my sorrow and send my condolences to all who knew him well. I feel your loss is a loss for me also.

Michael E. Keller
Lancaster, PA

Dear Nuts & Volts:

Nuts & Volts is an excellent magazine for all kinds of people in the field of electronics: pro, student, amateur, business person, etc. Including more article vendors and suppliers will help the magazine grow even farther for the simple reason that there are computers in every field, even in homes. I think more information on computers, parts, assembling, repair, etc. will bring more readers and advertisers.

Molz Abbas
East Meadow, NY

Dear Nuts & Volts:

Loved Scott Edwards' article on PCB design in *Nuts & Volts*, but I enjoyed his response to Karen Cardwell's nasty and pompous comments even more. Keep up the good work, Scott; you're one of the most knowledgeable and gifted writers in electronics.

Ron Reis

Dear Nuts & Volts:

I would like to respond to the article in your May '96 issue, written by Gordon West on pages 22-23.

I enjoyed the article (May '96) and expect to contact several of the hams that you mentioned in your article about their antennas, especially the clover-leaf, which I used 25+ years ago and haven't seen since.

I take exception to your selection of M2's Eggbeaters, which in

the satellite community are referred to as the "deadbeaters." The almost total lack of performance out of these antennas is shameful for M2 to market. An example follows:

I am the radio officer on a ship and brought all my stuff with me to operate the pacsats with exception of antennas. I had ordered these and they were being direct drop shipped to my agents in Guam. As I had about two weeks before my antennas came in, I connected an X-50 Comet antenna up to one run of my Aircom cables for the two-meter uplink (with 100 watts at the antenna). I stripped back an existing piece of RG59 that had a coax connector already on it, stripping back about 6.5 inches of center conductor. I plugged this into my SB-70 SSB electronic mast-mounted preamp and taped the braid shield to the

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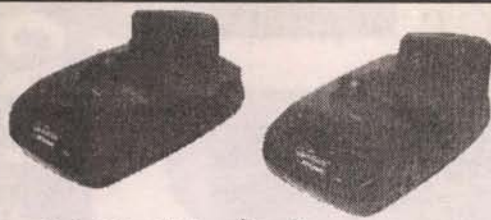
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reader FeedBack

handrail with electrical tape, leaving the center conductor more or less stuck in the "up" position. This served as my receive antenna. When I got back into the shack, I found I was now in the middle of a KO-23 pass and ended up getting over 150 K of data, using the center piece of 72 ohm coax for an antenna! Over all, it didn't work great, but I did have passes with over 380 K of data. I got into the queue regularly and uploaded very well with the Comet for xmit ant.

I got my eggbeaters in and here is what happened then: I mounted both a two-meter and 435 MHz eggbeaters with ground-plane kits on the top of the mast of my ship. They were in the clear at 176 ft and nothing on their level, or higher. I fed the two-meter one with 100 watts (at the antenna) and below the 435, I had the SSB electronic SB-70 preamp. I

checked the SWR of both antennas and found no reflected, even measuring at the antennas.

Performance with the eggbeaters: Non-existent. They were totally dead below almost 20 degrees and dead for the most part above 30. The best pass I ever had with them was only 85 K of data. I rechecked connections, changed positions of transmit and receive antennas; no difference. In the two weeks I had them, I removed the groundplanes, put them back, etc. I was never able to make them perform, period. The groundplane kits are advertised to increase the overhead performance; they showed no difference, whatsoever. I was only able to make two uploads during this time.

Since that time, there have been a number of discussions on the sats about them, and there has never been anything positive. I gave mine away to a fellow who gave them away, to a fellow who threw them out, and cussed at the fellow who gave them to him for

wasting his time. People I have talked to in the USA, Denmark, Sweden, etc., have all gotten disgusted they spent money on them and discarded them.

For use with a repeater, they are an almost total loss. Their performance on the horizon is awful. When in Saipan, 90 miles north of Guam, the people there with beams could barely hear me, but when I switched to the 2 M/440 MHz dual band Comet, I was 20 dB over 9 (so to speak). The horizon to 30-34 degrees is the most important time for LEO satellites, if you figure the total time a satellite is "visible" during a month, something like 85-90 percent of the time the satellite will be below 35 degrees. Concentrating over 35-40 degrees is a waste of time and money (unless you have beams).

I ended up going with Hustler Spirits, 0 dB gain verticals as they will withstand the service here at sea. They are truly commercial built. I regularly get 500 K of data

out of them and my best is 980 K, which is as good or better than some with beams. I feel this is because I have lots of Japanese to download stuff (hi) and the vertical (as checked by Scientific Atlanta on their antenna range) has an almost perfect 0 dB pattern to 40 degrees. I wish I had the gain, but my pattern to the vertical would decrease rapidly.

I have written M2 and sent E-Mail and never had a response. I would suggest you not recommend this antenna to anyone, they will be angry.

73s Gordon, and the best to you, and I otherwise enjoyed the article.

Cliff Ward
WA5LVG@amsat.org

Dear Nuts & Volts:

I recently got burned for \$14.95 plus postage after inquiring about an ad stating you can obtain sound for your VCII and VCII Plus. What I received was a two-page diagram of hooking up

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reader FeedBack

your VCR to your cable and using the audio output connected to a stereo amp or receiver. You simply use the audio from the cable TV tuned to the corresponding channel of your satellite system. I hope other readers don't make the same mistake I did. I love to tinker on various projects and was lead to believe that there was a way to set up a test condition to check the VCII board for proper audio operation. Thinking that the digital audio on the system can be received without codes. I should have known better. Once burned, twice shy! Hope this will save other readers from being suckered by these scams. If so, I gladly act as the guinea pig.

Anonymous

Dear Nuts & Volts:

In Don Lancaster's article on batteries, no mention was made of nickel/iron alkaline secondary cells. In the chemical plant where I worked in 1950, our forklift vehi-

cles were powered by nickel/iron cells which gave excellent service.

The Encyclopedia Britannica said that compared to lead/acid, it has longer life, lighter weight, greater robustness to vibration, immunity to harm due to standing in discharged condition, being over-discharged, short circuited or charged in reverse direction (I have copied their wording). Capacities were given as follows:

Lead/Acid 7-9.6 watt hrs/lb.
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(Perry Enc.Chem. Eng.)

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Philip E. Curry
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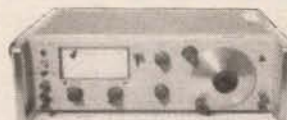
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by
Harry Helms

Director or Asymetrix ToolBook, such as the ability to handle mouse enter/leave events or to perform mathematical calculations.

Faced with a loser product for CD-ROM development, Microsoft

the main topics in the Help file in the order in which they appear. To look inside each "chapter" for its subtopics, just click on each chapter title beside the book icon.

The index part lists the topics and subtopics in the Help file in alphabetical order, as shown in Figure 2. The user can scroll through a list of topics or enter a keyword in the text box at the top to quickly move to the area where the topic is listed.

The find part searches the list of topics and subtopics for those that contain a word or phrase entered in a text box. A list of topics and subtopics containing that word or phrase is then displayed in the middle box in order to narrow the search down. In the bottom box, there will be a final list of topics narrowed down from the selection in the middle box. The final subtopic desired can be displayed by highlighting it and then clicking the "Display" button.

Once a page in a Help file is opened, Help supports several useful features. A common one is the pop-up window. Pop-up windows are most commonly used to display definitions of terms. Another common feature is the jump, which opens another topic in the Help file. The usual convention for Help files is to use green underlined text for a jump and green dotted-underline text for pop-up windows.

Help also supports "training cards," as shown in Figure 3. Training cards are able to communicate with the program the Help file supports; they can send messages to the program or receive messages from it. Training cards are especially useful for guiding users through complex procedures that can be broken down into a series of steps. Figure 3 shows the training card Help system used by the Windows95 Help Authoring Kit. A variety of buttons and accompanying commands can be specified for training cards, including next, abort, ignore, retry, yes, no, and OK. Help uses the WM_TCARD message to communicate with the program through the Windows95 applications program interface (API).

Help can be used to create context-sensitive Help files. A context-sensitive Help file is one users can access while directly working in a program, such as by clicking on a question mark icon or by clicking a "Help" button in a message box. Context-sensitive Help gives users direct access to information when they need it. For example, a dialog box might ask the user whether they want to perform or cancel a certain operation. If users are confused as to what they should do, a context-sensitive Help button in the dialog box would allow users to go directly to a Help file page on the topic. This is much easier on users than closing the message box, opening the Help file, and then searching for the page containing the desired information.

While context-sensitive Help is easier for users, it's also more difficult to create. Authoring of context-sensitive Help follows a process much like that described later in this column, but references to the desired topic must be included in the program code at the appropriate places. In this month's column, we'll

Software Wizardry

decided to re-name the product and re-position it as a tool for Help file creation. (The Windows95 Help Authoring Kit can import Viewer files and re-compile them for Windows95, however.) If you're familiar with the Windows 3.1 versions of Encarta, then you have a good idea of the sort of Help files you can produce for Windows 3.1 PCs.

What's Involved

Developing a Help file is a three-step process:

1) Create a "topic file" consisting of your text, graphics, and other elements (sound, etc.) that you want included. This is a word processing document saved as a rich text format (.RTF) file.

Answering Calls for Help in Windows95

2) Create a "project file" that contains instructions on how the different elements of the topic file should be compiled. A project file is created in the Help Workshop and the resulting project file has the .HPJ file extension.

3) Compile the topic file, various graphic files, and the project file into a single Help file and test it.

Of course, Help authoring is not entirely that simple! However, it is much easier than trying to create an equivalent Help file using a programming language like C or Delphi.

Structure of a Help File

The Help files produced by the Windows95 Help Authoring Kit have three distinct parts selectable by "tabs" at the upper left of the Help file window. The three parts are: contents, index, and find.

Let's take a look at the Help file that comes with the Help Authoring Kit. Figure 1 shows the contents part; this is the default selection when the Help file is launched. This is like the Table of Contents of a book or magazine, and lists

Being good isn't good enough in software these days. It's the thoughtful details that separate market winners from losers. And one of the biggest features end users appreciate is good Help files accessible from within the program itself.

Creating Help files for Windows PCs has long been a pain in the nether regions. However, it just got a whole lot easier. Microsoft has released their Windows95 Help Authoring Kit at a list price of just \$49.95. The only other tool you'll need is a copy of either Microsoft Word or WordPerfect to create the text files.

What makes Help files you create with the Help Authoring Kit special is that they aren't restricted to plain vanilla text. You can make areas of the text "hot" so users can jump to a different topic or see a pop-up window when the text area is clicked. You can add graphics as bitmaps (.BMP files) or Windows metafiles (.WMF files) or in two special formats used with Windows Help. You can make graphics "hot" as well. Graphics can be used as the entire background for a Windows Help page. Video (.AVI) and sound (.WAV) files can be easily added as well.

The ability to develop killer Help files belongs in any software developer's tool kit. With the introduction of the Windows95 Help Authoring Kit, there's really no excuse for not having it.

Inside Help Authoring

The Windows95 Help Authoring Kit is mainly intended to create Help files for Windows95 and Windows NT 3.51 and higher software. However, it can also be used for software intended for Windows 3.1 and Windows for Workgroups PCs if you distribute Win32s along with your software or do not use some features supported only in Windows95 and Windows NT. No other platforms, like OS/2, are supported. The Authoring Kit gives a complete description of the features not supported in Windows 3.1. However, the resulting Help files are still better than most Windows 3.1 Help files.

The Windows95 Help Authoring Kit doesn't have much in common with Help file creation tools for Windows 3.1. However, it does have a good bit in common with one Windows 3.1 development tool, namely Microsoft Viewer.

Viewer was Microsoft's first attempt at a multimedia development system (the 1992 and 1993 versions of their Encarta encyclopedias were created using Viewer, for example). As a multimedia development tool, Viewer was a bomb. It was mainly text-oriented and didn't support most of the functions included in competitive products like Macromedia

Help Topics: Help Author's Guide

Contents Index Find

Click a book, and then click Open. Or click another tab, such as Index.

- Getting Started
- What's New in Version 4.0
- Designing your Help system
- Step-by-Step Procedures
- WinHelp Reference
- Converting from Viewer 2.0

Figure 1

Software Wizardry

Contents Index Find

Figure 2

1 Type the first few letters of the word you're looking for.

2 Click the index entry you want, and then click Display.

topic files to project files
A-footnotes
A1 macro
A-keywords
AL macro
ALIAS section of project files
aliases, adding
aliasing topic IDs
aligning
 bitmaps in topics
ALink macro
ALinks
 about keyword jumps
 marking a topic as an ALink target
 new topic-linking features
 testing
 using with multiple Help files

just discuss creation of Help files within the environment of the Help Authoring Kit.

Creating the Topic File

You can use Microsoft Word 6.0 or WordPerfect 6.0a (or later) to create a topic file. The file must be saved in rich text format (.RTF) form. The only real difference when creating a topic file in WordPerfect is in handling footnotes, which are widely used in topic files. Word uses characters instead of numbers to format footnotes; the Help Authoring Kit includes a full description of how to insert the correct footnotes in WordPerfect. Footnotes are used to construct the index and find parts of a Help file. Indexing and searching functions are keyed to the type and arrangement of footnotes within the topic file.

Text can be made bold or italicized, changed in size, or changed in color using the usual tools in Word or WordPerfect. Different Help topics are separated from each other in the text file by inserting page breaks between topics. Different topics are identified by using footnotes; the text of the footnote becomes the identifier for the topic in the Help file. For example, one of your topics might be on how to access your company's Web site. You would create the text for that subject in your topic file, and then separate it from

other topics by inserting a page break before and after the subject. You would add a footnote before the first word in the section, and the footnote could be something like "Web Access." That would become the name of that section throughout the rest of the Help file.

The ability to assign identifiers to different sections of your Help file is very powerful. You can create links to other sections by including references to the linked sections using hidden text. For example, you may want to allow users to jump to another section of the Help file or to display a pop-up window when they click on a word or section of text. This can be done by single or double underlining the text (depending on whether you want a jump or pop-up window) and placing the

identifier of the linked section or pop-up window in hidden text after the underlined section.

Help provides a set of macros that can be executed by jumping to them. These macros include ControlPanel (opens a control panel properties dialog box), FileExist (determines if a specified file is on the user's hard drive), and ExecFile (causes a program to run). The latter function can be used for some very interesting effects. For example, the phrase "ExecFile(notepad.exe)" in hidden text after a word or section of text will cause the Windows notepad to appear when clicked. You could also write a short executable (.EXE) program using C or other compiled language that could be executed by ExecFile. Suppose you wanted to link a Help file to your company's Web site. You could write a program to launch a Web browser and transfer your company's Web address to it whenever ExecFile is clicked. Microsoft has used this technique with their Help files for Microsoft Office 7.0; a button click sends the user to a Microsoft Web page via the Microsoft Network.

Adding Graphics and Cool Stuff

Graphics can be a terrific addition to a Help file, especially now that computing is so visually oriented. Like other Windows programs, Help lets you add

graphics in the form of bitmaps (.BMP) and Windows metafiles (.WMF). In addition, Help supports two graphics formats used exclusively (at the moment) by it: segmented hypergraphic (SHED) bitmaps (.SHG) and Help multi-resolution bitmaps (.MRB).

A graphic can be inserted into a Help file by directly pasting it in. Another way to add graphics is with a graphics statement. Graphics statements are useful if you will use a graphic more than once in your Help file;

the graphics file can be saved once and then called as often as needed by a graphics statement. This saves disk space. The three graphics statements are: bmc (places the graphic in a paragraph where the reference to it is placed); bml (aligns the graphic along the left margin); and bmr (aligns the graphic along the right margin). The letter "t" can be added to make a graphic transparent. For example, bmlt would align the graphic along the left margin and make it transparent. Graphics statements are followed by the file name of the graphic and are placed in brackets.

Audio and video can be added to a Help file by using the Windows mci (media control interface) interface function. You enter mci followed by the name of the audio or video file you want to play and enclose both in brackets. You can add various options between mci and the file name; for example, the word repeat will cause the file to be repeated after it plays. Audio and video files can be quite large, so these probably should be avoided unless you're running the entire software from a CD-ROM.

Adding Hot Spots

A jump or link is an example of a Help "hot spot." When the user moves the mouse cursor over a hot spot, the cursor turns into a pointing hand to let the user know something will happen when the mouse is clicked. We've already discussed how to create hot spots in text by underlining text and inserting the identifier for the jump or pop-up text in hidden text. If text is single-underlined, a pop-up window will be displayed; double-underlined text is used for jumping to another topic in the Help file. Pop-up windows are assigned identifiers like other sections of text. You can change the way hot spot text looks, but the usual Windows standard is to use underlined green text for a jump and dotted underlined green text for a pop-up window.

You can also make a portion of a graphic into a hot spot or add multiple hot spots to a single graphic. Such a graphic is called a segmented hypergraphic, and is created using the Hotspot Editor feature of the Help Workshop. The Hotspot Editor places a box with sizing handles on the graphic, and this box can be positioned anywhere on the graphic. Only the area covered by the box will be a hot spot, and more than one box can be placed on a graphic. A segmented hypergraphic is stored as a .SHG file.

Putting It All Together

Several different types of files are compiled together to generate a single Help file. One is the topics file, which is the text file saved in .RTF format. The various graphics files (.BMP, .SHG, .WMF, etc.) are also compiled, as are any audio or animation files you include. Finally, the project file (.HPJ) is also compiled to produce the resulting Help (.HLP) file.

We haven't mentioned the project file too much this month, but a project file window is shown in Figure 3. The project file puts the various graphics, animation, and audio files in the desired order and also sets properties (such as text colors and styles for jumps and pop-up windows) for the Help file.

Authoring a good Help file with multimedia features is now only slightly more difficult than using more applications programs and you usually don't need any programming skills. If you develop Windows95/NT software, there's no reason not to have a terrific Help file for your users. And if you'd like to add a very useful skill to your professional tools, mastering the Help Authoring Kit would be a smart move. NV

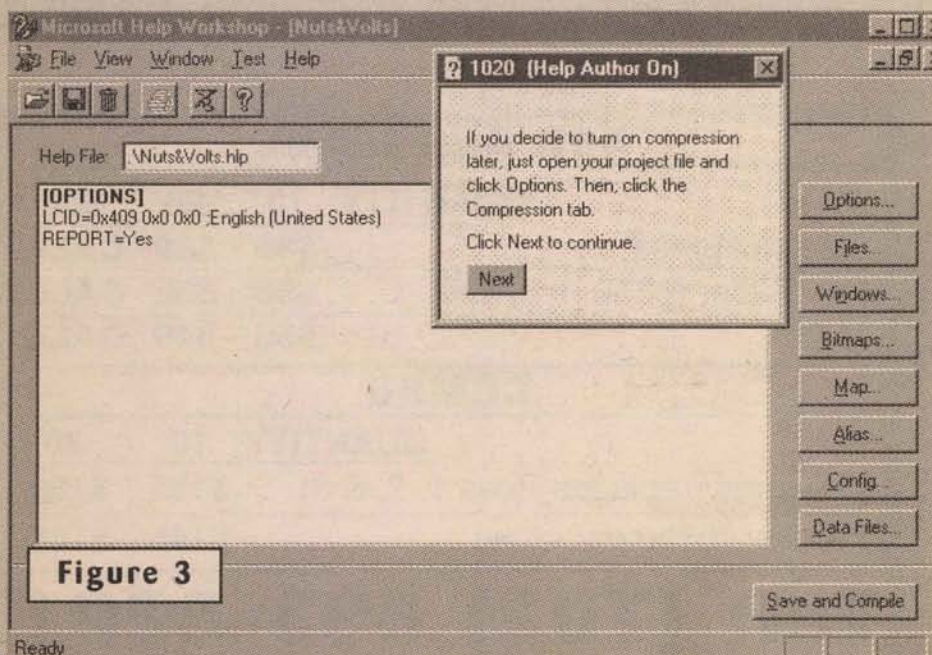


Figure 3

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Tom G. - FL Excellent Service, fast and quick. The only bad thing about this company is they don't sell Cable Boxes. We hope someday they will.....

David P. - CA We called around for help on filters and nobody had any answers except one, call the "THE FILTER COMPANY" we did and had an answer in a matter of minutes.....

John B. - IL Our company buys in the 100 quantities and needs a large selection of different channels. "The Filter Company" was the only one who was able to supply.....

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Electronics Q & A Continued from page 91

Where Did I MOVE My File?

Q. Using the MOVE command, I accidentally moved a document to a misspelled (hence, non-existent) directory. I've searched all my drives and directories for it (a horrible day's work) with no success. Did the machine just chew up and swallow the file? Is there any way I can bring it back from Hades or Limbo or wherever it's gone to, or do I just bid it a fond farewell?

**Robert Baron
Athens, GA**

A. You've just discovered a thrilling secret feature of MOVE. If you specify a path that MOVE doesn't recognize, it doesn't move the file at all, it simply renames it and leaves it in place. (MOVE behaves exactly like RENAME in this case.) Look for your file in its original location, under the (misspelled) file name of the directory where you thought you'd sent it. Incidentally, this occurs only when you move single files. If you try to move a group of files to a nonexistent directory, you'll be prompted to say whether you want DOS to create the directory for you.

MAILBAG

It's been 20 years since I lived in Japan, so I might have some details wrong, but the fact of the matter is that Japanese voltage really isn't 110 volts - nominally or actually. Japan was the first Asian country to electrify and the two major population centers were electrified by two different companies at two different times. The Kanto region - Tokyo, Yokohama, and the regions to the North are - 220 volts 60 Hz. The Kansai region - Osaka, Kobe, Kyoto, and the South - are 100 volts 50 Hz.

The three or four consumer appliances I bought in Japan that I brought back to the US all had transformers with taps at 100, 110, and 220 volts, so converting them to run in the US was no problem except for the alarm clock that people keep toggling the 50-60 Hz switch on then complaining that it runs fast.

**Don Kenney
via America Online**

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Tel: (702) 893-6201

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TECH FORUM

Continued from page 16

could cause problems.

A small (1"H x 1.25"W x 7"L) B/W CCD camera with similar (identical?) "pixelized" output as the Fisher Price camcorder was being sold about a year ago for \$30.00+ \$5.00 S/H by Lionel Trains, Inc., P.O. Box 748, New

Baltimore, MI 48047-0748. Check for current availability and price before sending for one. If the camera is no longer available from Lionel, check with Images company, P.O. Box 140742, Dept. N, Staten Island, NY 10314. Also, see "The Laser Experimenter" in the Nov. '95 issue of *Nuts & Volts* for

an article featuring this camera.

John McMichael
Laramie, WY

ANSWER TO #11969 - NOV. 1996

The "no return pulse" error is the IRD telling you that a sensor in the actuator is not working. The sensor consists of a magnetic switch or hall device switch which reads "pulses" from a rotating magnet on the actuator shaft. The IRD counts these pulses to determine which satellite the dish is aligned with (part of the set-up procedure when aligning the dish). The actuator may continue to move, but the IRD has no idea where it is focused. Go back out to the dish and open the motor box where the wires enter and check for loose or corroded connections. Check the same behind the IRD.

If the wires aren't bad, you either have a defective sensor (new ones are available from Skyvision 1-800-543-3025) or something is wrong inside the IRD itself in the interface to the sensor.

I had a similar problem, found and fixed corroded wires and found the satellite presets still worked.

Joe Leikhim
Tallahassee, FL
Jleikhim@netally.com

ANSWER TO #11961 - NOV. 1996

The simplest way to convert a pulsed signal from an infrared transmitter of any brand and then convert that signal into an on/off switch is with the help of a 567 phase lock loop tone decoder.

The 567 is a simple device that can be wired to receive any frequency in the form of sound, light, or straight electrical signals from an external source, and then lock on to that signal to activate an external device of your choosing.

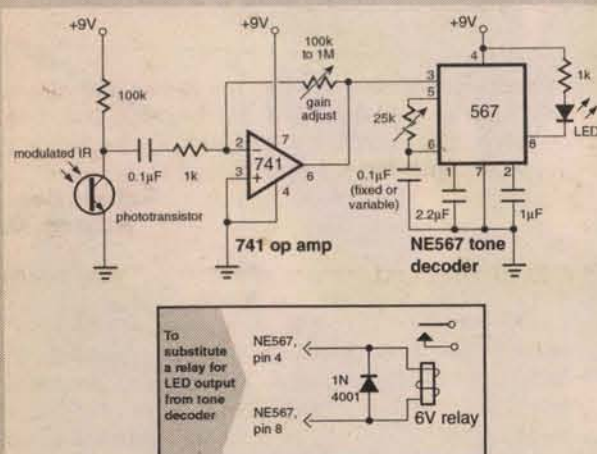
The tone decoder is tunable to any frequency within .01 Hz to 500 KHz, which means that you can tune it to any brand of remote and any button on that remote of your choosing.

You don't need to know the frequency of your remote control device if you install a variable resistor (pot) and/or variable capacitor to the timing circuit of the 567, as this will allow you to tune the device to any frequency within its limits.

The output of the 567 can directly drive a LED six-volt relay, or an SCR; or it can be connected to a transistor which, in turn, operates a larger relay of a higher voltage or current rating.

To increase the sensitivity of the input, you can couple a lens to the photo sensor and a 741 op amp, which can also be configured with an adjustable gain, which will ensure that your device will still operate from a weak signal (long distance).

Chris Smith
Bieber, CA

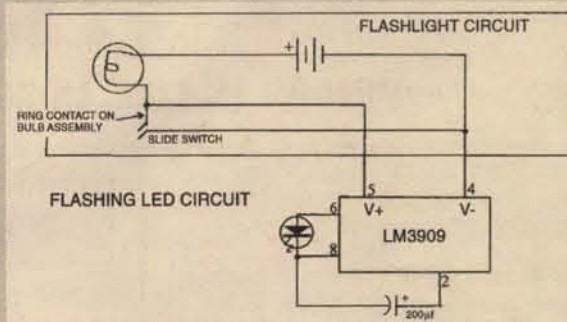


ANSWER TO #11964 - NOV. 1996

Connect the positive power connection of the LM3909 to the ring contact of the bulb assembly. This will supply power to the flasher through the low resistance of the lamp when it is off. When the lamp is turned on, the ring contact is connected to the battery negative, therefore the flasher circuit will be off. Don't worry about the flasher draining the batteries. With the circuit shown below, the LED draws current only approximately 1% of the time, and the other 99% of the time only draws 50

µA. This results in well over a year of operation with ordinary C or D cells before significant battery capacity would be used.

R. R. Dunn
Modesto, CA



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TECH FORUM

cpoosupport/indexes1/dj5ser.html

If you do not have net access, it can be downloaded off of the HP Computer Bulletin Board at 208-344-1691.

If you still have trouble after installing the latest printer drivers, the problem may be in the interface cable that you are using. Many of the new HP printers communicate with the computer via the bi-directional parallel port. Some cheaper printer cables are not compatible with these printers. If all else fails, check your warranty and call HP and have your unit serviced through the Corvallis repair center. This telephone number is: 1-800-243-9816.

Paul Stafford
Lewisville, TX

ANSWER TO #10968 - OCT. 1996

Your X-10 computer interface is made by X-10 Inc. They are still in business and can be contacted at:

X-10 (USA) Inc.
91 Ruckman Road, Box 420
Closter, NJ 07624-0420
201-784-9700
800-526-0027
x10usa@aol.com

The same interface is sold by Radio Shack as the Plug 'n Power computer interface, so they should also be able to order a manual for you.

If you have Internet access, you can get a copy of the X-10 frequently asked questions document (FAQ). It contains information about many X-10 devices, including programming information for the computer interface. The FAQ is available by FTP at [ftp://ftp.scruz.net/users/cichlid/public/x10faq](http://ftp.scruz.net/users/cichlid/public/x10faq) or by E-Mailing a request to x10faq-request@cichlid.com

Doug Smith
Roscoe, IL
dougs@mcs.com

ANSWER TO #11963 - NOV. 1996

It is best to keep repairing or replacing the optical sensor. These sensors are vital to the safety of life. A person should NEVER bypass a life saving feature on any device, including an overhead garage door. Garage doors can kill people quite easily. In many communities, optical sensors are a requirement, regardless of who lives in the home. Modifying the unit to work without the sensor would place all liability on the owner for any accidental injury or death. In short, the consequences far outweigh the headache elimination in repairing the unit.

Mark Hanz
Houston, TX

ANSWER TO #11968 - NOV. 1996

What you need is to replace the +200 volt filtering capacitor. You can replace the cap which is connected to the cathode of the 200-volt rectifier on pin pt. 3 of the flyback trans. Or simply add a 33 MF 250-volt cap on the pix tube socket board, the negative side to ground and positive side to the common end of the three resistors which are connected in series with the collectors of the three-color output transistors.

Kamal
Van Nuys, CA

CHASE NOISE WITH THE BIG EAR

by Jim Ford N6JF

Actually it is called "The Supersonic Ear" and is smaller than, no ... make that *much* smaller than the parabolic dish (and excellent book) named *Big Ear* by John Kraus W8JK of Ohio State University, used for outer space research.

This new toy, manufactured by Wild Planet Toys of San Francisco, is available for \$15-\$20 from stores such as Toys R US, Imaginarium, and Target. It can help you or your power company find power-line noise. Read on to see how.

Do You Really Have Power-Line Noise?

Power-line interference can show up on your TV set, AM or FM radio, ham radio, CB, or other receiving devices.

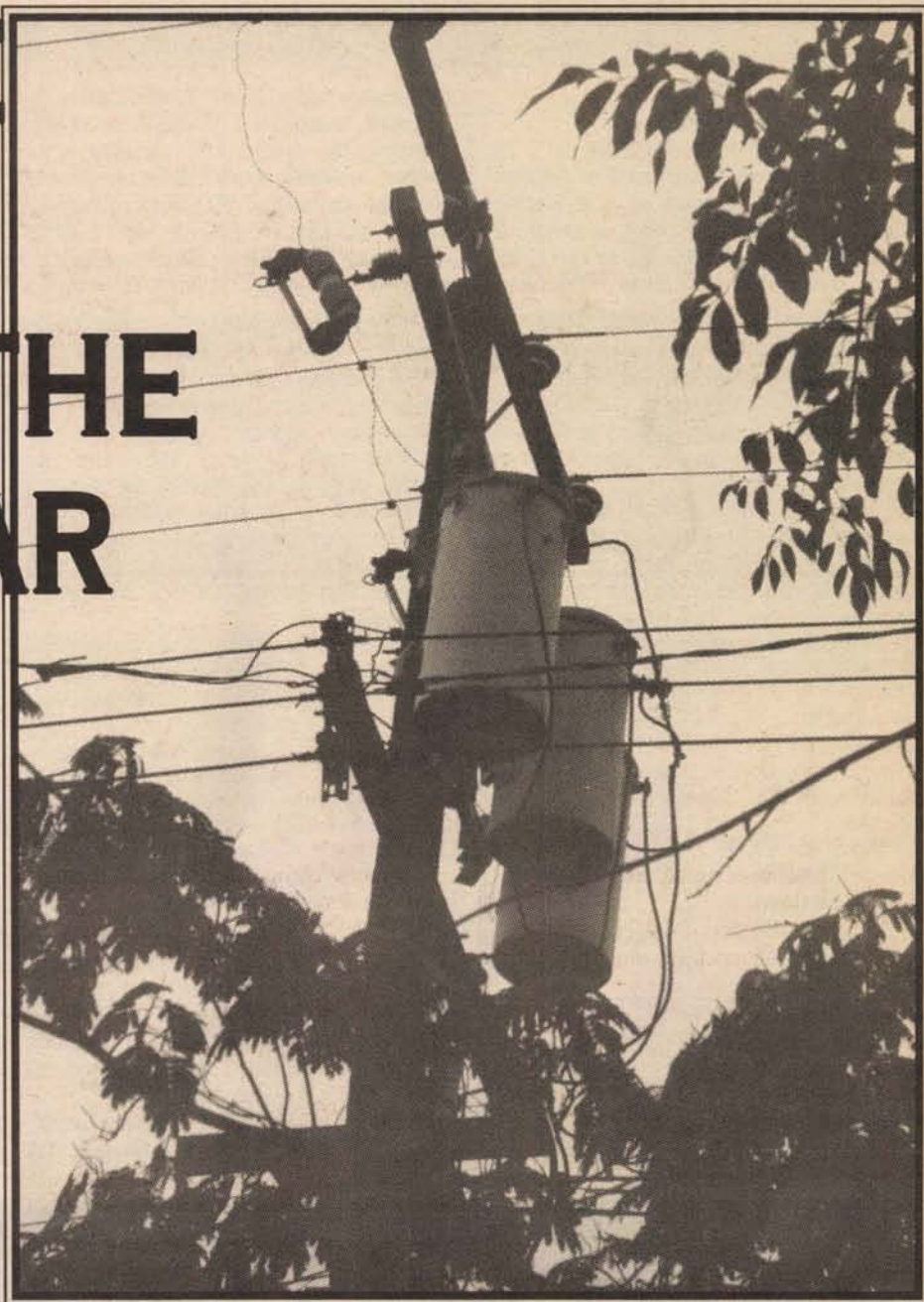
The power companies are sometimes blamed, but are not responsible for many kinds of noise problems. Examples are heating pads, touch lamps, door bell transformers, electric motors, electric fences, computers, and other electronic equipment.

A very common problem is the thermostats in fish aquariums (there are non-interfering versions available). Most of these noise problems usually come from within your own home; although, in severe cases, they can come from around the neighborhood.

I had interference once that was traced to a flea chaser. This was a higher-than-human-hearing pulsed oscillator driving a speaker that was suppose to chase fleas from an area. This caused weak interference, but it was about a block away in someone's garage! When confronted with the problem, the homeowner gave it to me and said it didn't work anyway.

To check to see if noise is in your own home, you can selectively turn off your circuit breakers to see if one of them eliminates the noise.

I must admit one time I didn't follow this procedure and was red faced by blaming a cable TV company for interfer-



Typical 14 KV distribution power pole.
Loose and dirty hardware can cause a lot of noise problems.

ence that was actually caused by my touch lamp (the kind you just touch to turn on and off). Breaks in the shielding of the coax owned by the cable company can, however, cause interference to certain portions of the two-meter ham band.

Power-Line Noise "Signature"

The easiest way to tell if you have power-line noise interference is to look at your TV set on channels 2-6. Power-line noise will normally show up only on these channels unless you have an extremely bad case.

The interference shows up as bands of horizontal lines that slowly creep up the screen. Interference is weather-dependent and is usually worse at night, during fog, and other high humidity conditions.

Channel 2 usually gets the worst interference since it is the lowest frequency channel. The higher the channel number, the higher the frequency. Most of the time, the interference gets slightly better as you go toward the higher channel numbers and stops at channel 7. Usually there will be no interference at all on channels 7 and higher. Arcing produces a very broad spectrum of energy with decreasing amplitude the higher you go in frequency. There is a big gap in frequency between channel 6 and 7, and the decreasing energy with frequen-

cy makes the channel 7 and higher interference infrequent.

A TV is a good detector for power-line noise even if you are just concerned about noise to a ham radio. All this assumes you are not using cable TV and have some kind of external antenna.

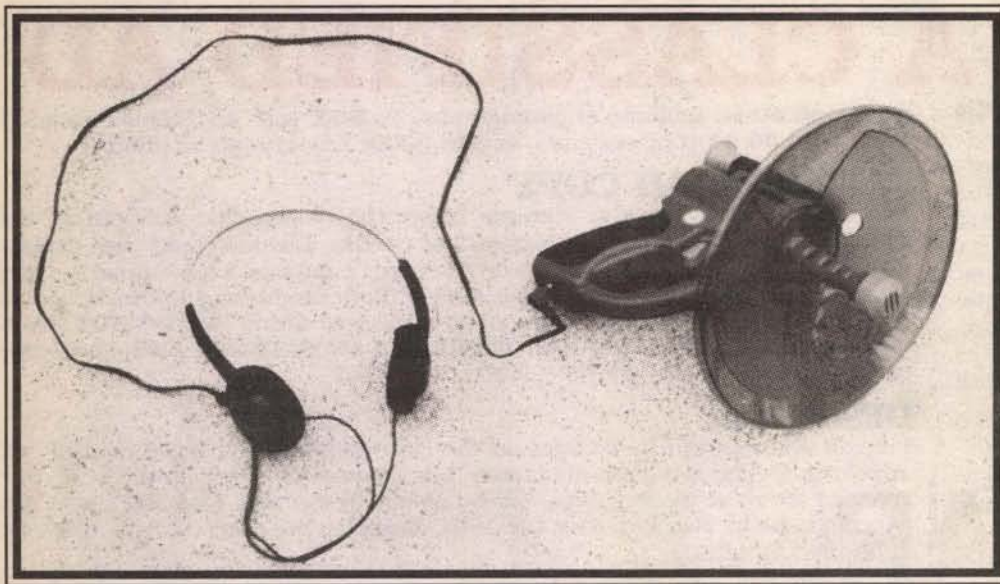
If you are on cable and still get the bands of slowly upward creeping lines, then your cable company probably is picking up power-line noise at their community antenna site.

Remember local channel 2 may actually show up as some higher channel number (e.g., channel 37) because of frequency translation associated with cable TV, so you may still get power-line noise symptoms even on a channel that normally is too high in frequency to get interference.

Hams may notice their noise blanker on their HF transceiver does not work very well to eliminate power-line noise. Noise blankers work good on signals that have a high pulse to average content such as an ignition pulse. Apparently, the noise blanker gets confused with the lower peak to average noise that comes from power-line noise.

How to Track Down Interference

No matter what the interference, the first step is to make sure it is not



The "Supersonic Ear."

caused by something within your house by turning off circuit breakers as mentioned earlier. If the interference is outside, then you need to "DF" it. By that, I mean use directional antennas in conjunction with the "Supersonic Ear" if necessary.

If you are a ham and have roof-mounted directional antennas, by all means, use them.

In my experience, 14 MHz is the lowest useful frequency for direction finding with higher frequencies such as two meters much better. The reason is the true location and apparent location of noise often differ because power-line noise travels down the line. The higher in frequency you search for noise and still get enough noise to get a reading, the better. This is partly due to the difference in wavelength, and partly due to smaller more directional antennas. It's best to DF an initial directional bearing from a high spot, perhaps on your roof, to minimize any signal reflection confusion.

From there, hoofing it is necessary. A small two-meter beam antenna in conjunction with a "handi-talkie" are a good DF combination. It is helpful to have some kind of signal strength indicator, but not necessary because you can listen for the noise. The effectiveness of the walk around DF method varies with the type of interference.

If you have power-line noise, then you still may get confusing bearings. It might help to check the polarization of the interference. Power-line noise tends to be horizontally polarized, so you may have to turn your beam antenna sideways.

I have two equal gain two-meter yagi antennas; one is vertical and the other is horizontally polarized. I can instantly switch between both antennas, but horizontal noise is always stronger with the vertical at times a close second. There must be a component of both horizontal and vertical polarization in power-line noise.

Enter "Supersonic Ear"

Often tracking closer than a hundred yards or so is difficult because of confusing DF bearings. This is when the listening ability of the Supersonic Ear can help. You can then scan the various poles in the area to "see" if you hear arcing type noises. Be sure to test for noises at other non-suspect poles first to get an idea what a normal pole sounds like.

I was not sure such a small dish could pick up the noise, but was pleasantly surprised to find out it could. This dish has more gain in the higher audio range. In fact, it is very effective when listening to birds.

Using a small parabolic dish for DFing noise is an idea already used by some power companies, although with larger versions (approximately two feet). I have been told they are also used for locating leaks in overhead pressurized cables.

I have not tried, but thought of adding to the dish with the right kind of puffed-up garbage can lid. Some look like they may be a parabolic shape. Even if the lid is not exactly the right shape, it would probably still add to the gain.

The audio gain of the Supersonic Ear is high. More audio gain would cause mike/headset feedback problems unless an earmuff type headset is used.

Larger dishes could locate noise from a farther distance, but may cost 10 times more. If you want more gain with no hassle, consider getting one of these (try Edmund Scientific).

Practical Tips

Once you determine you have power-line interference, the power company should take it from there. There are reasons, however, that you should be involved in the process.

Most power-line noise that causes TV and radio interference is moderate, but not severe. The severe interference is often found not by DF techniques, but by binoculars, or even the naked eye because you can see or hear the arcing. These severe interference problems are usually short-lived because they are easy to find and important to the power company to fix quickly for fire prevention.

The moderate interference that

hams have (although severe to them) is often intermittent in nature. The interference will often be bad one night and gone the next day and night! When the power company checks for interference during the day, they often don't find anything, or if they do, it's a problem too far away to be a major problem for you. That is why it is a good idea to write down the times, dates, and intensity of interference.

Humidity has a major effect on power-line noise. This is especially a problem along coastal areas. Usually the more humidity, the more power-line noise. There are exceptions because often, if you have very humid conditions such as fog, the power-line noise will be bad for a while until the dirt and contamination get washed away.

The time since the last rain affects the interference, as well as any dust or wind storms. Sometimes there is no interference for a couple of days right after a good rain.

Dry winds alone can cause a type of interference that shows up on a TV as a random shot gun pattern over the whole screen. This is probably caused by static build-up and discharge, and is

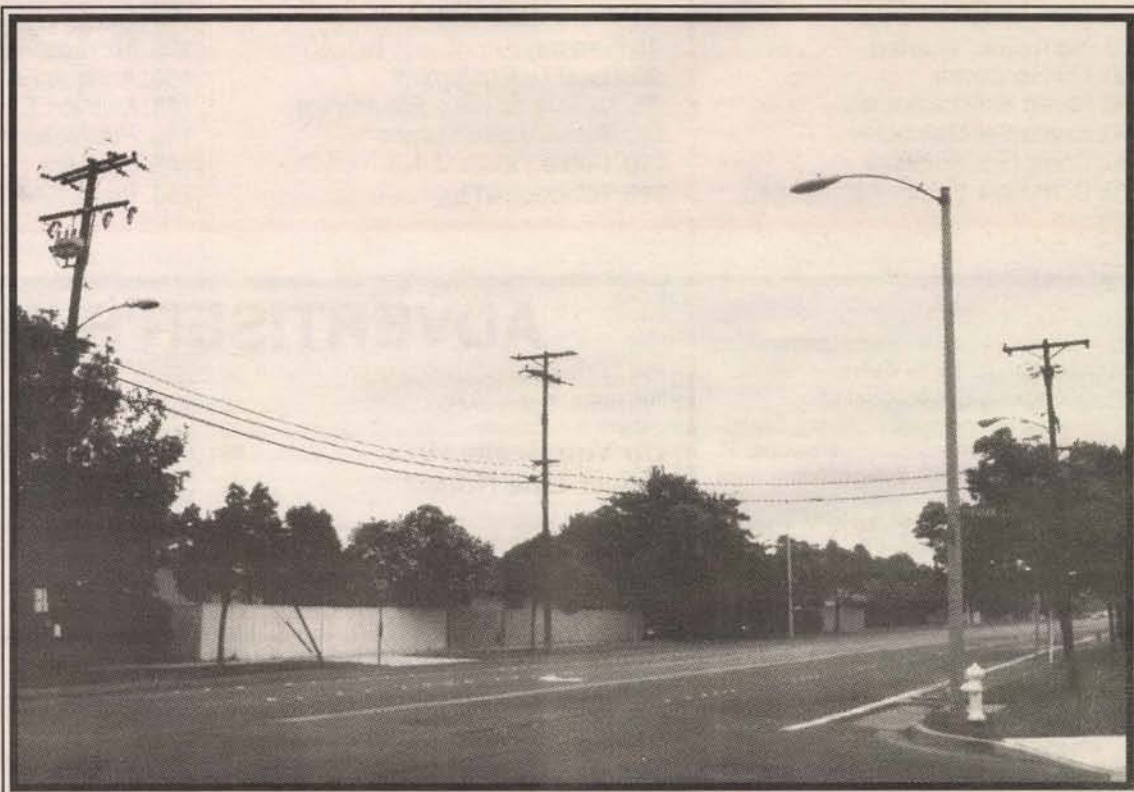
It is my impression that it takes special permission and overtime to work at night to find power-line noise. This scheduled overtime night may not be the same night you have interference.

This was the problem I had over 10 years ago when my battle to fix noise lasted over a year! Oh, I don't mean they were not trying to fix the problem, but I suspect there was pressure to make a find on those overtime nights and turn in a repair work order. That repair work order fixed someone else's problem three or four blocks away if you didn't have interference that night. They eventually become tired of spending money on your problem. That is why it is important to have a good working relationship with the power company so you can save both time and money. If they believe in your tracking ability, they will go and check your pole first.

Some larger power companies have a full-time staff of power-line noise specialists. A few even assign certain people to work solely with hams to resolve problems. Many smaller utilities have a person to do it on a part-time basis.

Fortunately, power companies have become smarter concerning noise interference. They know that certain hardware (particularly loose hardware) causes noise.

In the past, "dead ends" were a



Which pole now? Once the noise is "DF"ed to a small area like this, the Supersonic Ear can DF some more.

difficult to fix.

It would be a good idea to record outdoor humidity along with the dates and times. I have seen surplus sling psychrometers for sale for about \$20.00. These are accurate humidity gauges that use two thermometers and a wet-bulb/dry-bulb difference to calculate humidity.

All this hassle and record keeping are important because it helps your credibility and shows determination with the power company.

Fixing power-line noise is unfortunately not often a speedy process. Power outages are the repair crews first priority, not your TV or radio interference. Also, they like to find it during the daytime when the problem is not always there.

frequent problem, I'm told. This is where the high voltage (14 KV) distribution line terminates or terminates and turns a corner. Why that was a particular problem, I don't know. They also have developed noise-resistant hardware for use on the power poles. This newer noise-resistant hardware is not yet in use everywhere.

Finally, if you still can't get the cooperation you want from your power company, a letter to the PUC (Public Utilities Commission) may help. Your letters to the power company and any other documentation such as times, dates, etc., and nature of interference (remember the upper moving lines on the TV), will help your case. Most power companies cooperate, making this unnecessary. **NV**

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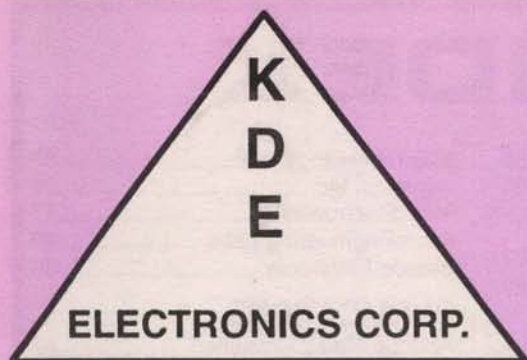
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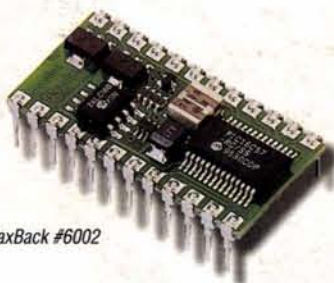
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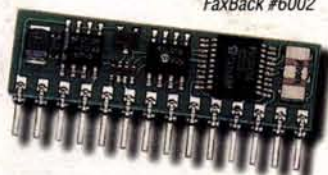
What do you want for Christmas?

A BASIC Stamp, of course!

Modules shown 20% larger than actual size.



FaxBack #6002



FaxBack #6002

BS1-IC Module
8 I/O lines
80 PBASIC instructions max.
2000 instructions/sec.
2400 baud serial I/O
14-pin SIP module

\$34

Familiar PBASIC language with I/O instructions for pushbuttons, EEPROM access, potentiometers, pulse measurement, PWM, serial I/O, sound, etc.

BS2-IC Module
16 I/O lines
500 PBASIC instructions max.
4000 instructions/sec.
50k baud serial I/O
24-pin DIP module

\$49

Similar language as BS1, plus touch-tones, frequency generation, pulse counting, serial shift registers, X-10 powerline control, etc. I/O functions common to both modules have a higher resolution on the BS2-IC, due to its faster clock speed. With its rich feature set, the BS2-IC is the most popular BASIC Stamp we make.



FaxBack #6004

New! 4-line Serial LCD \$109
New 4-line serial LCD display is fun and useful for projects that require interaction with people. The display only takes one I/O line to operate, and can be controlled using simple SEROUT instructions in your BASIC Stamp programs.



New! BASIC Stamp Starter Kit \$79

Contains everything you need to get started with BASIC Stamps. Includes our original BASIC Stamp rev. D, plus manual, software, and programming cable. All you need is an IBM PC running DOS. If you're a student or educator, please ask about our special discounts.

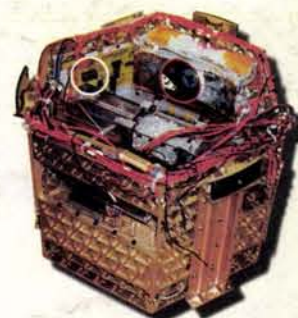
BASIC Stamp discussion list on the Net!

The list works like this: lots of people (currently 900) subscribe to the list, and then all questions and answers to the list are distributed to all members. It's a fun, fast, and free way to discuss BASIC Stamp issues.

To subscribe to the list, send email to majordomo@parallaxinc.com and write **subscribe stamps** in the body of the message.

BASIC Stamps in Space!

Mel Torrie and his students at Utah State University used a BASIC Stamp II in their experiment to see how the growth of foods might be affected by a near-zero-gravity environment. The experiment was flown on the Space Shuttle Endeavor on May 19, 1996, and downloaded its data as planned to the Kennedy Space Center. The BASIC Stamp II can be seen inside the white circle (near the left side of the container).




BASIC Stamps Fight Fires

John Piccirillo built Marvin, a fire-fighting robot shown in the photo. Marvin is actually a very complex device, using two BASIC Stamps and a host of other circuits and sensors to become an intelligent fire-fighter. All by itself, Marvin is able to sense the location of a small fire (usually a candle), then move to the fire, and then extinguish the fire with a CO₂ cartridge. Mr. Piccirillo was kind enough to allow us to take Marvin to the Embedded Systems Conference in September, where countless on-lookers inspected the robot.

Little Green Men from Mars

Bjarne Bergheim, Ken Christian, William Jackson, and Ben Strayer worked on "the Flying Saucer Project" at the University of California, Irvine. Their project, which used two BASIC Stamp II modules, was a literal flying saucer. Although not as dramatic as Hollywood versions, their saucer did indeed fly! And fortunately, it didn't come on Independence Day.



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